PROCEEDINGS OF THE CONFERENCE ON FLEET MARINE FORCE COMBAT CASUALTY INFORMATION SYSTEM

E. K. E. GUNDERSON
M. W. CONGLETON
D. M. RAMSEY-KLEE

REPORT NO. 84-15

NAVAL HEALTH RESEARCH CENTER
P.O. BOX 85122
SAN DIEGO, CALIFORNIA 92138-9174

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND

Proceedings of the Conference on Fleet Marine Force Combat Casualty Information System

San Diego, California

2-4 April 1984

Edited by

E. K. Eric Gunderson, Ph.D.
Michael W. Congleton, LCDR, MC, USN
Naval Health Research Center
San Diego, California

and

Diane M. Ramsey-Klee, Ph.D.
R-K Research and System Design
Malibu, California

A-1

TABLE OF CONTENTS

Executive Summary

The Conference on the Fleet Marine Force (FMF) Combat Casualty Information System consisted of four major sessions and a number of demonstrations. Session I consisted of introductory background presentations. Session II consisted of technical presentations on three major topics; Session III convened three technical work groups on these same topics for in-depth discussions; and Session IV provided summaries of the work group discussions and an evaluation of the Conference.

In Session I, background material was presented as a framework for the Conference and included a review of progress that previous conferences had achieved toward defining system requirements, functions, essential data elements, and specifications for development of an information system to support patient care in the Fleet Marine Force. The results of those earlier conferences included preliminary identification of necessary data elements for the basic combat medical record and description of echelons at which these data elements should be recorded. This working definition of data requirements provided the basis for prototype software components demonstrated at the present Conference; this software represented a number of essential functions involved in collection and distribution of casualty information from the forward battle area to definitive care facilities in the rear.

Sessions II and III consisted of technical presentations and work group discussions. Both sessions were focused on three major topics which reflected the principal objectives of the Conference: (1) prototype components of a combat casualty care information system; (2) hardware and data capture devices; and (3) combat casualty databases and trauma care procedures. Several existing software components and a number of data input and storage devices were examined to evaluate what might be utilized for the FMF application.

Session IV consisted of summaries of the work group discussions followed by overall evaluations and recommendations from conference participants. Generally, it was felt that the conference filled an important need to examine combat casualty care issues. Recommendations from the floor included the following: scheduling another conference in about a year; establishing a close working relationship between the Army's Theater Army Medical Management Information

System (TAMMIS) project and the Navy FMF combat casualty information system project, and forming an expert panel on military trauma care to guide simulation of combat triage/treatment/evacuation scenarios using the Naval Amphibious Medical Evacuation Simulation (NAMES) model.

The results of the conference will be used to define a combat casualty medical record, develop software tailored for each echelon of casualty care, and identify appropriate hardware based on the most advanced technology and capable of withstanding the severe environmental conditions that may be encountered in a combat setting.

Preface

The Conference on the Fleet Marine Force (FMF) Combat Casualty Information System convened at the Seapoint Hotel, San Diego on 2 April 1984. The purpose of the conference was to bring together experts in Navy medicine, trauma care, computer systems, and software design in order to evaluate progress to date and to provide feedback and guidance for future information system development. The program consisted of four major sessions including a general session for background, conference objectives, and organization; eleven technical presentations under three topical areas; three concurrent work group discussion sessions; and a final session for summarization and evaluation. Demonstrations of prototype software for an FMF combat casualty information system and hardware and data entry devices for field use were also conducted during the Conference.

The Conference was sponsored by the Naval Medical Research and Development Command, Bethesda, Maryland, and was hosted by the Naval Health Research Center, San Diego, California. Approximately 75 persons from the Navy, Marine Corps, Army, Air Force, and private sector participated during the three days of the Conference. Many important topics pertaining to the requirements for a combat casualty information system were addressed. The content of these presentations and discussions is summarized in the Proceedings.

Participants*

Janice Anderson
Software Development WDC/FSI
TAMMIS
8610 N. New Braunfels #501
San Antonio, TX 78213

Towne Bannon
NAVMASSO DETPAC
Box 217, Naval Station
San Diego, CA 92136

Judith Barger
USAF/Chief Nurse, Medical
Operations Division
Aeromedical Casualty
Systems Program Office
Brooks AFB, TX 78235

Donald D. Beck
Computer Consultant
Rt 1, Box 102
Paso Robles, CA 93446

Richard F. Bergfeld
Associate Director
Advanced Army Systems
Litton Data Systems
8000 Woodley Avenue
Van Nuys, CA 91409

CAPT Bernard R. Blais, MC, USN
Force Medical Officer
Military Sea Litt Command
Washington, DC 20390

CAPT C. W. Bollinger, MC, USN
Chief Occupational Medicine
Naval Hospital, Code 037
Bremerton, WA 98314

Dr. Franklin R.Borkat
Biomedical Engineer
Naval Ocean Systems Center
San Diego, CA 92152

CAPT J. J. Bouvier, MC, USN
Naval Hospital
San Diego, CA 92134

Eugene A. Brickhouse
TRIMIS Program Office
5401 Westbard Avenue
Bethesda, MD 20816

HMC David J. Buechel, USN
HMC/USN 3rd MAW DET
Medical Department
Marine Corps Air Station
Yuma, AZ 85369

Col. Thos. F. Camp, MC, USA
Research Program Director
Combat Casualty Care, USA
HQ MRDC
Ft. Detrick, MD 21701

CAPT John E. Carr, MC, USN
Commanding Officer
Naval Hospital
San Diego, CA 92134

LCDR Michael W. Congleton
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Dr. Michael L. Cowan
USUHS
Chairman Operational
and Emergency Medicine
15 Guy Court
Rockville, MD 20850

CDR Robert F. Coxe, MSC, USN
Head, Medical Section
Doctrine Dept. (Code 925)
Marine Corps Development &
Education Command
Quantico, VA 22134

CDR J. R. Crim
Group Surgeon
1st FSSG, FMF PAC
518 Zeilin Street
Camp Pendleton, CA 92055

CAPT Larry D. Diamond, MSC, USAF
AFMSC/Medical Systems Division
Brooks AFB, TX 78235

LCDR Mark C. Diehl, DC, USN
Naval Dental Research
Institute
Bldg 1H
Great Lakes, IL 60088

William Flies
Datakey, Inc.
12281 Nicollet Avenue
Burnsville, MN

LCDR James D. Ford, MSC, USN
Health Care/RDT&E
Analyst, OP-093
OP-933D3
Pentagon, Washington, DC

CAPT M. F. Fornes, MC, USN
Naval Hospital
P. O. Box 165
San Diego, CA 92134

*Titles and addresses as shown on Conference registration form.

Dr. Arden W. Forrey
Dept. of Surgery
University of Washington
School of Medicine at
Harborview Medical Center
325 Ninth Avenue
Seattle, WA 98104

LT William P. Frank, MSC, USN
Health Services Support
Officer
1st FSSG - CSS-7
Bldg. 1495
Camp Pendleton, CA 92054

CDR L. M. Fraser, MSC, USN
Naval Medical Command
MEDCOM 411
Washington, DC 20372

Jack Frogue
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Dr. Frank C. Garland
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Dr. James G. Garrick
St. Francis Memorial Hospital
900 Hyde Street
San Francisco, CA 94109

CAPT Robert W. Gaugler, MSC, USN
Asst. for Research and
Development (Code 02R)
Naval Medical Command
Washington, DC 20372

LCDR Fred Glogower, MSC, USN
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Edward Gorham
San Diego State University
Student Contractor
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Vernon L. Groeber
U.S. Army Soldier Support
Center
Ft. Harrison
Indianapolis, IN 46216

Dr. E. K. Eric Gunderson
Head, Environmental Medicine
Department
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

LTC M. P. Gustat III
TRIMIS Program Office
5401 Westbard Avenue
Bethesda, MD 20816

LCDR James C. Helmkamp, MSC, USN
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138

CDR Joseph Henderson, MC, USN
Naval Submarine Medical
Research Laboratory
Naval Submarine Base
Groton, CT 06349

Larry Hermansen
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Dr. Erwin F. Hirsch
Boston City Hospital
818 Harrison Street
Boston, MA 02118

Ms. Anne Hoiberg
Research Psychologist
Environmental Medicine Dept.
Naval Health Research Center
San Diego, CA 92138-9174

CAPT Noel S. Howard, MC, USN
Special Asst. for Combat
Stress Contingency Planning
Naval Medical R & D Command
Naval Medical Command
National Capital Region
Bethesda, MD 20814

Dr. Norman J. Jacknis
Project Manager/TAMMIS
Project/
U.S. Army Academy of
Health Sciences
8610 N. New Braunfels Avenue
Suite #501
San Antonio, Texas 78217

Major Michael W. Jiru
HQ USAF/Office of the SG
Medical Readiness Division
HQ USAF/SGHR
Bolling AFB
Washington, DC 20332

Dr. Laverne C. Johnson
Chief Scientist
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

CAPT James F. Kelly, DC, USN
Commanding Officer
Naval Medical Research and
Development Command
Naval Medical Command
National Capital Region
Bethesda, MD 20814

2LT Charles Krutsinger
Project Engineer
Directorate of Research,
Development and System
Acquisition
USAF/AMD
Brooks AFB, TX 78235

Major Gary N. Lacher, USA
U.S. Army Soldier
Support Center
Combat Developments
Health Services Officer
ATTN: ATZI-DDL
Ft. Harrison, IN 46256

CAPT J. E. Lang, MC, USN
Commanding Officer
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

CDR E. J. Loos, MSC, USN
Administrative Officer
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Major Manuel Marquez
Chief, Readiness Plans
Section
HQ AF Manpower and
Personnel Center
HQ AFMPC/MPCYR
Randolph AFB, TX 78150

CAPT Clyde H. McAllister,
MC, USN
Force Medical Officer, FMFPAC
Camp HM Smith, HI 96861

CDR Brian G. McCaughey,
MC, USN
Deputy Head, Environmental
Medicine Department
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Col. Robert D. McWilliam
Project Manager - Theater
Army Medical Management
Information System
Directorate of Combat
Developments
Academy of Health Sciences
Fort Sam Houston, TX 78234

RADM Roger F. Milnes
Deputy Commander
Fleet Readiness and Support
Naval Medical Command
(MEDCOM-02)
Washington, DC 20372

Dr. George Moeller
Naval Submarine
Medical Research Lab
Naval Submarine Base
Groton, CT 06349

LCDR John E. Montgomery, MSC, USN
Executive Officer
First Medical Battalion
First FSSG
Camp Pendleton, CA 92055

Col. Robert H. Mosebar
Academy of Health Sciences
Ft. Sam Houston, TX 78234

Michael Nave, Director
Naval Medical Data Services
Center Detachment San Diego
Naval Medical Command
Southwest Region
San Diego, CA 92134

CDR Dennis Nelson, MSC, USN
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Richard J. O'Connor
U. S. Army Medical
Bioengineering R & D
Laboratory
Fort Detrick
Frederick, MD 21701

Dr. Joseph Osterman
Director of Programs
Naval Medical R & D Command
Naval Medical Command
National Capital region
Bethesda, MD 20814

Dr. Larry Palinkas
Environmental Medicine Dept.
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

HMC Harry D. Penny, Jr., USN
Medical Admin. Chief
Health Services Support Unit
1st FSSG
Camp Pendleton, CA 92055

William M. Pugh
Program Manager, Medical
Information Systems
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92138-9174

Dr. Diane M. Ramsey-Klee
R-K Research and System
Design
3947 Ridgemont Drive
Malibu, California 90265

Dr. Paul B. Richards
Director, Fleet Medical
Support Office
Naval Research Laboratory
Code 1206
Washington, DC 20375

Dr. Bernard L. Ryack
Submarine Medical
Research Laboratory
Behavioral Sciences
Department
Naval Submarine
Base New London
Groton, CT 06349

Dr. William J. Sacco
President, Cyometrics,Inc.
25 West Courtland Street
Bel Air, MD 21014

HMCS John F. Sauln, USN
Field Medical Service School
Camp Pendleton, CA 92055

Kathleen Scott
Software Development
TAMMIS Project Functional
Analyst
National Data Corporation
Federal Systems, Inc.
8610 N. New Braunfels Avenue
Suite 501
San Antonio, TX 78217

COMO H. James T. Sears, MC, USN
Commanding Officer
Naval Hospital
Oakland, CA 94627

CDR Douglas M. Strong, MSC, USN
Program Manager
Fleet Health Care Systems
Naval Medical R & D Command
Naval Medical Command
National Capital Region
Bethesda, MD 20814

Conference on the FMF Combat Casualty Information System

Agenda

Monday, 2 April

0900-1200	Registration/Demonstrations of Software and Hardware
1300-1600	Session I: General Session Dr. E. K. Eric Gunderson - NHRC (Chairman) Captain J. E. Lang - NHRC CDR D. M. Strong - Naval Medical Research and Development Command William M. Pugh - NHRC
1600-1800	Software/Hardware Demonstrations
1500-1700	Cocktails (Pt. Loma Room, Seapoint Hotel)
1715	Dinner

Tuesday, 3 April

0830-1145	Session II: Technical Presentations
0830-0930	Prototype of Combat Casualty Information System William M. Pugh - NHRC (Chairman) LCDR Michael W. Congleton - NHRC Dr. William J. Sacco, Cyometrics, Bel Air, MD Dr. George Moeller - Naval Submarine Medical Research Laboratory, Groton, CT
0930-1030	Hardware and Data Capture Devices Dr. Franklin R. Borkat - Naval Ocean Systems Center, San Diego (Chairman) William Flies - Datakey, Inc., Burnsville, MN Major Gary N. Lacher - Fort Benjamin Harrison, Indianapolis, IN Dr. Franklin R. Borkat - Naval Ocean Systems Center, San Diego, CA
1030-1045	Coffee Break
1045-1145	Combat Casualty Databases and Trauma Care Dr. Frank C. Garland - NHRC (Chairman) Dr. James G. Garrick - St. Francis Memorial Hospital, San Francisco, CA Dr. Arden Forrey - University of Washington, Seattle, WA CDR Joseph Henderson - Naval Submarine Medical Research Laboratory, Groton, CT CDR Brian G. McCaughey - NHRC
1300-1630	Session III: Technical Work Groups Section A: Prototype Software System (William M. Pugh, Chairman) Section B: Hardware/Data Capture Devices (Dr. Franklin R. Borkat, Chairman) Section C: Combat Casualty Databases and Trauma Care (Dr. Frank C. Garland, Chairman)
1630-1800	Chairmen Prepare Work Group Summaries and Recommendations
1800-1900	Cocktails, Dinner

Wednesday, 4 April

0830-1030	Session IV: Presentations of Work Group Summaries and Recommendations
1030-1045	Coffee Break
1045-1130	Conference Wrap-up (Dr. E. K. Eric Gunderson, Chairman) Concluding Remarks (Captain James F. Kelly)

Demonstrations

During the first day of the conference, various types of technology that might be used to automate medical information processing in field environments were demonstrated. These demonstrations included hardware devices designed to withstand the rigors of field combat operations, different methods developed to expedite data capture, and software developed to manage medical records in the field.

Included in the demonstration of ruggedized hardware was a digital communications terminal which weighed less than five pounds and had 128K bytes of memory. A Data Tag consisting of a an alterable semiconductor encapsulated in a special hard plastic material also was displayed. Major Gary N. Lacher from the U.S. Army Soldier Support Center was present and demonstrated the Army's implementation of the Data Tag while others demonstrated how the Data Tag technology could be interfaced with other microprocessors such as IBM-compatible machines.

Data capture methods included a hand-held device that would automatically record vital signs such as blood pressure and temperature, and CDR Joseph Henderson of the Naval Submarine Medical Research Laboratory showed how information such as a trauma score could be down-loaded from a hand-held processor into a larger microprocessor. Other data capture methodology was demonstrated by Dr. Franklin R. Borkat of the Naval Ocean Systems Center who used a bar code reader to enter data into a portable computer.

Software demonstrations included a system which adapted V.A. File Manager software to combat casualty data handling and a system that created a graphic depiction of organ functioning from a patient's clinical data. In addition, Dr. George Moeller and Dr. Bernard L. Kyack from the Naval Submarine Medical Research Laboratory demonstrated computer aids for submarine hospital corpsmen; and William M. Pugh, Donald P.Beck, and LCDR Michael W. Congleton demonstrated a system for tracking personnel and maintaining medical records in a field environment.

Introductory Presentations

Dr. E. K. Eric Gunderson, NHRC (Conference Chairman): Welcome to the FMF Combat Casualty Information System Conference. I would like to express my appreciation to all of you for participating in these meetings.

I would like to ask Captain Gene Lang, Commanding Officer of the Naval Health Research Center and your host for the Conference, to start us on the right track with some opening remarks. Captain Lang.

Captain J. Eugene Lang, MC, USN: Admiral Milnes, ladies and gentlemen. Welcome to San Diego. We are very pleased to have you join us for this important conference. This all began several years ago when Dr. Gunderson and I attended a conference on occupational health problems of the Navy held at the Battelle Institute in Seattle. Experts in occupational medicine, researchers, and computer specialists met to address the problems of documenting environmental hazards and protecting naval personnel and employees from the multitude of toxic substances and agents used in naval industrial facilities. It was the unanimous consensus of that gathering that there was a critical need for an information system to assist occupational health programs to carry out all of the directives and requirements for recordkeeping and reporting to higher authority that were overwhelming people in the field. Shortly after the Battelle Conference, NHRC started work on the Naval Occupational Health Information Management System (NOHIMS). When the need for a medical information system to support combat casualty care in the Fleet Marine Force was established recently, it seemed quite appropriate to apply the knowledge gained developing NOHIMS to this new task. NHRC is rapidly becoming recognized as a center for software development to support Fleet operational needs.

I welcome you, and I hope that you will have an enjoyable and productive conference. Thank you.

Dr. Gunderson: Some of you might not know this, but Captain Lang has recently joined the ranks of the personal computer enthusiasts. He has been trying out all kinds of software packages on his new Zenith computer, learning the jargon, and rapidly becoming a computer addict. I hope to join him soon with my own hardware, so that I too can share the joys of personal computering.

Now I would like to introduce CDR Mike Strong, Program Manager for Fleet Health Care Systems at the Naval Medical Research and Development Command in Bethesda, Maryland. The R & D Command provides the funds and program guidance for research and development on medical information systems and is the sponsor of this meeting. Mike and I communicate quite a lot by electronic mail which tends to be rather cryptic and impersonal, so it is nice to be able to communicate face to face for a change. After receiving an urgent document from me by electronic mail, Mike's first message to me on his DECMATE which is connected to our VAX computer was as follows:

From: Strong 18 Nov 1983 13:14
To: Gunderson
Subj: Electronic Mail

The system works and all is well,
The document's in hand;
We're jumping up and down with joy,
And pleased to beat the band.

Here's to a future filled with MAIL,
And accomplishments galore;
That Navy and Marine Corps, too,
Will not perceive a bore.

So on we go with POM in hand,
And full of spirit and fight;
With dreams of discs, modems, and chips;
CPUs, PCs and bytes.

CDR Strong will give us an overview of this project from the R & D management perspective.

CDR Strong: Thank you, Eric. Admiral Milnes, ladies, and gentlemen. This morning I would like to present some information on the history and future plans

for this project. Previous conferences and workshops sponsored by the Naval Medical Research and Development Command (NMRDC), dealing with the subject of combat casualty care, have identified the need for improved recordkeeping capabilities in support of FMF operations. These conferences have also defined many of the health care functions that should be included both in garrison and in the field.

Although the deficiencies of medical recordkeeping, particularly during armed conflicts, have been cited throughout history, the report to the Bureau of Medicine and Surgery by Drs. Garrick and Carey was especially poignant. These two surgeons had been assigned a team of technicians to collect extensive medical records at DaNang, Vietnam in 1968. Over 2,000 combat casualties were treated during this process, providing invaluable insights into the problems of casualty care. It was their recommendation, following this experience, that in the future, people should be specifically assigned to this task. However, this report seemingly fell on deaf ears.

The first combat casualty care workshop was held in 1976 under the sponsorship of NMRDC and ONR. In that workshop, the following requirements were identified:

- Creation of a simple medical administrative information system

- Design of a structured form and complementary tag which contains all medical data and is machine readable

- Test data entry under field conditions

- Demonstrate an effective machine structure for the medical record for Echelon III/IV

- Develop a format for transmission of medical data for evacuation of casualties from echelon to echelon

- Develop a real time system for data reporting and feedback

The US/UK Maritime and Marine Combat Casualty Care Workshop which was held in 1981 identified the following additional requirements:

- Develop improved methods of patient management suitable for computerization

- Develop algorithms for triage, patient management, and evacuation

The Marine Corps and, in particular, the FMF has identified the need for improved medical recordkeeping. The Commandant of the Marine Corps in a letter in 1979 cited the following requirements:

- Develop a medical record system with continuity across medical echelons
- Develop a mechanism for placing medical data into a dog tag

The mid-range objectives plan for FY 84-93 also cite the need for deployable ADP support for the Fleet Marine Force. Recognizing the repeated statements calling for the development of such systems, NMRDC in conjunction with the Marine Corps sponsored an FMF Medical Information Systems Definition Workshop in 1982. The Workshop was designed to achieve the following objectives:

a. Definition of information management systems (and their features) required to support routine care, casualty care, and medical administrative functions at each field medical echelon.

b. Definition of field medical functions requiring information interfaces with line communications/logistics systems and fixed CONUS medical facilities.

c. Development of a prioritized list of requirements for RDT&E on field operational information management systems.

The report that was generated as a result of this Workshop eventually led to the generation of a Mission Element Need Statement (Appendix A).
The stated objectives of the MENS are:

- Develop complete medical data system designed to reduce the recording burden
- Design automated medical record, transferable throughout the evacuation chain and user friendly
- Enhance patient care and provide basic data for the medical regulatory and medical logistics systems

Based on these stated requirements, NMRDC funded a feasibility study at the Naval Health Research Center, San Diego, which was successfully completed in 1984. A request was made in the funding cycle for increased resources to begin in 1986 to accomplish this mission. The Surgeon General has supported this initiative and work has commenced. One of the main purposes of this conference is to acquaint everyone with the current status of the work and to provide a

forum for the other services, who are also involved with developmental efforts to present their current programs. This is an important task for all of us, and it wi be particularly important that all of these efforts are closely coordinated to avoid any duplication.

Yet to be resolved are the issues of how the FMF system will interface with the Shipboard Non-Tactical ADP (SNAP) program and the Army's Theater Army Medical Management Information System (TAMMIS). The requirements for the medical/dental module of SNAP have not been identified.

Urgently needed is a Navy Mission Element Need Statement which specifies methods for resolving these issues. This need is emphasized by the findings of the Long report on the disaster in Lebanon which criticized medical record-keeping and medical regulating practices and procedures. This concludes my presentation.

Dr. Gunderson: Thank you, Mike. Now I would like to present some of the recent background and history of NHRC's efforts to develop a combat casualty information system and an overview of what's to come at this Conference.

Design and development of medical information systems represents a relatively new area of work at this Center. One might call us the "new kid on the block." We are developing a significant in-house capability in medical information system design--perhaps the only one in the Department of Defense. However, we are not experts in field medicine, trauma care, combat operations, personnel and logistic matters, and so on. That is why you are here--to fill in some of the gaps in our knowledge and expertise. We need your help to review our assumptions and the work that we have done to date. We need the information and direction that you can provide--input that we regard as crucial to future system design efforts.

Computer hardware technology is advancing very rapidly. Computer equipment has become much more powerful, compact, and less expensive. Recent advances in information storage capacity have made possible a microchip in a dog tag that will contain 64,000 bits of information. Software development tends to lag well

behind hardware advancements, yet many feel that new software tools offer a major means of reducing time and costs of the horrendous recordkeeping and information management tasks that we must face in the future, especially in the medical field. Our recent work at the Center seeks to apply current hardware and software technology to various urgent Navy medical information needs as these become defined and documented. The potential usefulness of computer technology in medicine has barely been touched upon as yet. Many think that we are at the beginning of a new era of medical practice in which sophisticated computer systems will be indispensable for handling the vast amounts of information being generated. In the military establishment this transformation is just beginning to be felt in many of the major hospitals which have received TRIMIS computer systems to support a number of important medical functions and specialties.

In addition to the Fleet Marine Force project, we have experience in developing two other automated medical systems--the Navy Occupational Health Information Management System, or NOHIMS, and the Navy Mental Health Information System, or NAMHIS. NOHIMS has been partly deployed at two large Navy industrial sites, the Naval Air Rework Facility, North Island, and the Puget Sound Naval Shipyard, Bremerton, Washington. NOHIMS will be fully tested within the next year and a half at both of these sites. NAMHIS will be installed soon at the psychiatric clinic at Naval Station, San Diego for preliminary testing.

What is the combat environment in which a field medical information system will operate? Some features of that environment are described in the excerpts in the handout (Appendix B).

The first excerpt is a statement by Navy Surgeon General VADM Cox to a congressional subcommittee in 1982. This statement gives something of the probable sequence of events, the organizational elements involved, and the medical support capacities integral to a Marine Amphibious Force.

Admiral Cox went on in his statement to describe the large gap that existed at that time in the in-theater sophisticated medical care that should be provided by hospital ships and fleet hospitals.

At this Conference we would like to focus on medical information support during land operations several days after an amphibious landing when the medical

companies and the hospital company are ashore and operating. Our primary interest at this time is data pertinent to first aid, resuscitation and stabilization, acute trauma care, and initial surgery. This is in accordance with the FMF Mission Element Need Statement which says that Phase I of system development should provide an initial operating capability for only those data requirements that directly support the treatment of acute care patients in the field. Phase II will include development of all other identified data requirements. We would like to concentrate here on Phase I.

General Snowden's statement, which is the second excerpt in the handout (Appendix B), also provides a scenario for casualty care during a middle-sized amphibious assault. Let's hope that prospects for rapid evacuation and in-theater medical support have improved since General Snowden made his observations.

Admiral Eiseman in the excerpt from his talk (Appendix B) emphasizes uncertainty with respect to future combat environments, particularly uncertainty with respect to appropriate medical treatment and evacuation procedures under radically different weapons technologies. Some of you may have some thoughts about this question that you would be willing to share with us during the Conference: What is the combat environment for which the FMF medical information system should be designed? What impact will new weapons technologies have on treatment and evacuation procedures? Obviously, this is an enormously complex technical question that we cannot address here in any depth, but we cannot ignore it either. CDR Joe Henderson has touched upon these issues to some extent in two papers dealing with the tactical and epidemiological uses of combat casualty data: "A Medical C^3 Primer," U. S. Naval Institute Proceedings, Vol. 109, 1983, and "Epidemiology as a tool for combat care planning. Part I: Concepts," in the Report of the FMF Medical Information Systems Requirements Definition Workshop, 1982.

Let me now summarize briefly the history of the FMF project. A Technical Workshop on Combat Casualty Care was held in April 1976 at the Airlie House in Warrenton, Virginia. I believe that there are two people with us at this conference who attended that meeting: Captain James Kelly and Dr. Arden Forrey. This meeting was sponsored by the Naval Medical Research and Development Command

and the Office of Naval Research. The objectives of the Workshop were quite broad: (1) to identify specific problem areas in combat casualty care; (2) to determine whether identified problems were appropriately documented; (3) to establish priorities within identified problem areas; and (4) to recommend feasible biomedical research and development approaches. These tasks were considered in the context of the medical management of trauma patients which involved two basic aspects, patient evacuation and patient treatment. Generally then, the Workshop focused on basic problems involved in providing optimum treatment to combat casualties under various operational scenarios.

I shall only try to summarize briefly the findings of the Subcommittee on the Casualty Care Data System. This subcommittee concentrated on the collection and communication of clinical as opposed to administrative or resource management data. The stated requirements for clinical data were limited to the minimal information necessary for treatment of the patient at the next higher echelon simply because very little information can be supplied by care providers under the pressures of combat and rapid evacuation.

It was noted that the U. S. Field Medical Card (DD Form 1380) was inadequate in design and ability to withstand extreme field and combat conditions and that a new casualty tag was needed which involved minimal writing.

It was recommended that medical supplies and drugs used for treatment should be provided with removable labels containing both visual and machine-readable information. These labels could be affixed to the combat casualty tag, would serve as a record of initial medical treatment, and would subsequently be scanned for logistic inventory control and accounting.

The use of diagrams for surgical treatment records was recommended to portray body parts and organ systems. A second encounter form to provide more detailed medical information during evacuation and to supplement the initial combat tag also was recommended.

It was noted that only a small portion of the total military health record was needed in the combat zone; most of that record should be retained in CONUS, and battle casualty information should be inserted into that record later.

It was pointed out that for casualty care to be effective there must be cooperation and compatibility among the services.

I will not review the specific data requirements defined for each echelon by the 1976 Workshop because this issue was addressed much more fully by the 1982 Workshop.

The FMF Medical Information Systems Requirements Definition Workshop was convened in May 1982 in Bethesda, Maryland to identify requirements for the development of information systems to support patient care in the Fleet Marine Force. The scope of the Workshop was limited to information requirements from the forward edge of battle back to casualty receiving and treatment ships. It was recognized that any system which is developed must interface with other information systems currently available or under development. The Workshop was designed to achieve the objectives cited earlier by CDR Strong.

Workshop participants were drawn from U.S. Marine Corps Headquarters; Navy physicians assigned to the FMF; information and computer systems specialists from ONR, TRIMIS, NAVDAC, and the Navy Medical Data Services Center, and researchers from Naval Medical Research and Development Command laboratories. Of the 38 participants at that Workshop I think that about ten are here at our meeting today. The Workshop was divided into three different but overlapping medical functions: casualty care, routine care, and medical administration. I will try to summarize the findings and recommendations of the casualty care group only, because that will be the primary focus of this meeting. The Casualty Care Working Group considered clinical treatment functions involved in managing Marine Corps personnel with traumatic injuries at each echelon of care. Trauma casualty management included resuscitation; triage; pre-operative, operative, and post-operative care; and all supporting services. At this Conference we will postpone consideration of other supporting functions and concentrate principally on trauma casualty care. The following types of functions were seen as needing information support in a combat setting: acute trauma care, blood resources, laboratory, medications, and dietary services. The Working Group was asked to describe functions that needed information support and to assign the following priorities to those functions: high, medium, or low. The following functions were assigned a high priority: (1) patient identification, including name, SSN, unit, allergies, blood type, and religion; (2) times of injury and treatment, that is, at Echelon I times of

injury and morphine or tourniquet administration, at Echelon II times of various treatment procedures, and at Echelon III times of surgery and further treatment; (3) injury description and diagnosis: type and location of injuries, diagnoses of diseases, and description of nonbattle injuries; (4) Trauma Score to aid in triage, assess changes in clinical condition during evacuation, and provide both prognosis and feedback on treatment outcome; the Trauma Score could be introduced at Echelon II (BAS) and repeated at Echelons II, III, and IV; (5) treatment data: at Echelon I tourniquet, morphine, and first aid; at Echelon II, intravenous fluids, tubes, and sutures; at Echelon III blood replacement, surgery, immobilization, and casting of fractures; (6) diagnostic procedures; (7) medications; and (8) training in the use of data processing equipment and software which, of course, is not relevant to system design but would be essential for successful implementation of the system.

All of the data elements specified in the 1982 Workshop have been incorporated into the preliminary combat casualty software package that Dr. Mike Congleton of NHRC has created and is demonstrating here at the Conference.

NHRC design staff have participated in a number of other panels and conferences over the past two years focused on field medical information systems, notably the Hawaii International Conferences on System Sciences in 1983 and 1984 and the Symposium on Computer Applications in Medical Care meeting in Baltimore, 1983.

The objectives of this Conference are, of course, closely tied to the objectives of the FMF project. The primary objective of that project is to develop an automated recordkeeping and data management system for routine care and medical readiness in garrison and for casualty care in the field. The focus of attention at this meeting is on Phase I of that total effort--direct support of acute trauma care. The collection, transmission, and timely utilization of casualty data are considered vitally important for proper care of the wounded or ill patient as well as for medical regulating and resource accounting purposes. Little progress has been made in combat casualty data collection and management since World War II. (I served as an Army corpsman and helped take care of heavy casualties in the Battle of Bastogne during World War II, so I probably have the

most outdated combat medical experience of anyone here.) As the individual is evacuated through various echelons of care, reliable records of vital signs, resuscitation and emergency measures, treatments initiated, and further care required should be available at each stage. The 1982 Workshop made substantial progress toward defining system requirements, functions, and specifications.

In September 1983 NHRC hosted a follow-up meeting to lay out in some detail the data elements to be included in the basic combat medical record and at what echelons these data elements should be recorded. We now have a working definition of what the combat medical record should contain and have used this as a guide to develop a prototype software package or model to represent these essential functions and the flow of casualty information from the forward battle area to definitive facilities in the rear. At this meeting we would like to review and evaluate what has been done so far. Further decisions need to be made about the content of the combat medical record, data entry devices to be used, and the design of a new field medical card to replace the current battle injury tag. We would like your input into these questions before those decisions are made.

It is obvious that the FMF system involves unique problems and features. Combat casualty care is not just an extension of hospital or emergency medical care; it is an integral part of field military operations. The numbers and kinds of casualties are a direct result of the kind of military mission and the tactical deployment of forces. In an amphibious landing against well-defended positions, casualties will be many and severe. The success or failure of such a mission may depend almost as much on medical planning and efficient management of casualties as on fire power and logistics.

Bill Pugh, Program Manager for the FMF effort, will now describe our basic strategy for the development of an FMF prototype and our progress to date.

William M. Pugh: Thank you, Dr. Gunderson. Admiral Milnes, Captain Lang, ladies, and gentlemen. I am going to describe for you the development of automated information processing capabilities for combat casualty care.

Previous workshops held in 1976 and 1982 were very effective in identifying the medical information needs for combat casualty care, but now the point has been reached where methods for implementing various medical functions must be devised. Preliminary work on developing these methods has begun at the Naval

Health Research Center (NHRC), at the Naval Ocean Systems Center, and at the Naval Submarine Medical Research Laboratory. The focus of this work has been on the information needs at the first three echelons of medical care in the Marine Corps--the field corpsman, the battalion aid station, and the medical company. The goal is to improve the management of medical information in the field so that medical resources can be better managed.

The initial development efforts have been guided by the suggestions made by the participants of the previous workshops. Among these suggestions was the recommendation that the Field Medical Card be revised. Also, the participants of the previous workshops generally agreed that a combat medical record needed to be developed and that computer technology should be used.

In response to the first suggestion, we began work on a revised Field Medical Card. This work began by examining the current card which consists of heavy cardboard-like paper, is slightly larger than a computer punch card, and has a piece of wire attached to one end for securing the card to a casualty. Two alternatives to this card were developed after reviewing the previous workshop proceedings and meeting with individuals who have had experience with the present card. These alternative cards will be the subject of the presentation by LCDR Congleton.

Development of a Combat Medical Record is another work effort being conducted at NHRC. Although this work is related to the revision of the Field Medical Card, it is much broader in scope. The Combat Medical Record is at the foundation of medical information processing; it is the link between field medical information and medical data in other clinics or hospitals. Again this work began with a review of the previous workshops. In addition, an independent analysis has been conducted by Dr. Arden Forrey. Also, information has been obtained through the analysis of existing combat casualty databases.

Investigation of the feasibility of applying computer technology to medical information management has involved the evaluation of hardware and software development. A hardware survey and evaluation has been carried out by Dr. Borkat at the Naval Ocean Systems Center. He has reviewed available microprocessors, portable hand-held devices for electronic data entry and processing,

and a variety of electronic storage media including cards with a magnetic stripe and alterable semiconductor memory chips encapsulated in plastic.

Software development efforts include a variety of different programs to perform different medical functions. Program modules for capturing data for the Field Medical Card have been developed by LCDR Congleton. Also, software initially developed for an occupational health system has been adapted to perform personnel tracking and thus provide a basic personnel accounting system. Computer routines have also been developed by Dr. Sacco and his associates to compute an index of trauma severity and to display trauma results in a meaningful way. Finally, programs have been developed at the Naval Submarine Medical Research Laboratory in Groton, Connecticut for computer-aided diagnosis.

To coordinate and focus these different efforts, a preliminary system design has been developed. According to this design a microprocessor would be placed at the medical company. While in garrison this machine would be used to store basic medical history data, to generate reports on troop deployability, and to encode medical data on an electronic data tag prior to combat. During combat the microprocessor would be used to capture medical data on combat casualties and compile a patient record. These data would be retrieved to generate reports to include in the patient record, to send to the medical regulating agency, for personnel accounting, and for supply and replenishment. The system could also be used to analyze stored data to identify any illness trends, to supply information for computer-aided diagnoses, or to aid in triage management.

This brief overview has been presented to acquaint you with the development efforts that are currently underway. The following presentations will discuss the various programs in much greater detail. In addition, various hardware devices and software programs are on display. After you have seen the displays and heard the different presentations, we will conduct a series of workshops where your comments and suggestions will be solicited to guide our future work. At that time it would be helpful if issues of compatibility and doctrine were discussed. For example: What type of compatibility should be achieved? or, How should we achieve compatibility among systems? or, Should Marine Corps

doctrine be changed to accommodate computerized management of medical information?

Thank you for your attention, and, now I'll turn the meeting back to Dr. Gunderson.

Dr. Gunderson: Thank you, Bill.

The Conference is organized around three major topics which reflect the objectives of the meeting. The first topic is prototype software for a combat casualty information system. Bill Pugh will chair the technical presentations on this topic. Here our purpose is to examine existing software components that might be combined and adapted for the FMF application. Dr. Mike Congleton and Don Beck have created software designed to perform some of the critical functions needed. Don Beck has provided routines for identifying and tracking individuals through various environments and organizations. Accurate tracking of individuals is one of the key problems in the FMF application. Dr. Congleton has written software to collect, store, and display the data elements included in the new combat medical record that he and Bill Pugh have designed. Dr. Bill Sacco is here to describe and demonstrate the Trauma Score and its possible use in a military combat setting. The New London Submarine Medicine Laboratory has developed a series of computer aided diagnosis packages which may have applicability in later stages of the FMF project or to medical information systems for surface ships. Dr. George Moeller and Dr. Bernie Ryack are here to share some of that technology with us.

The second major topic is hardware and data entry devices. The Bioengineering Group at the Naval Ocean Systems Center has surveyed available hardware and data capture devices that might be suitable for the combat casualty setting. Dr. Frank Borkat will chair the technical presentations on this topic tomorrow, and Mr. Bill Flies, President of Datakey, Inc., and Major Gary Lacher from Fort Benjamin Harrison will discuss the Army's testing program for the electronic data tag. LCDR Roger Schultz from the Navy Military Personnel Command was scheduled to give a presentation on the Realtime Automated Ptaient Identification System (RAPIDS) project which involves encoding and storing information on a magnetic stripe on a credit card type device, but CDR Schultz was unable to attend, so Frank Borkat will present that material.

The final topical area to be discussed is the trauma care process and specifically a survey of existing combat casualty databases that might provide useful guidance for the design of a new combat medical record. Dr. Frank Garland from NHRC will chair those presentations, and Drs. Garrick, Forrey, Henderson, and McCaughey will describe several existing casualty databases and their potential usefulness for information system design. I am grateful to Dr. Erwin Hirsch from Boston City Hospital for attending the Conference. Dr. Hirsch was one of the surgeons who gathered the data that Drs. Garrick and Forrey will report on tomorrow.

The purpose of these technical presentations will be to provide enough information about current technology and available resources so that we can hold informed discussions in the Work Group Sessions Tuesday afternoon. We regard these discussion groups as the heart of the Conference and the principal opportunity for each of you to make a contribution to our knowledge, understanding, and future direction.

The Chairmen of the Work Group Sessions will present summaries of your discussions and recommendations on Wednesday morning. We will try to integrate these into a coherent set of findings and recommendations in the final session.

We are planning to prepare a proceedings of the conference and to publish it as a technical report from the Center. You all will receive copies of the proceedings when they are available.

Prototype Software Components of the Combat Casualty Information System

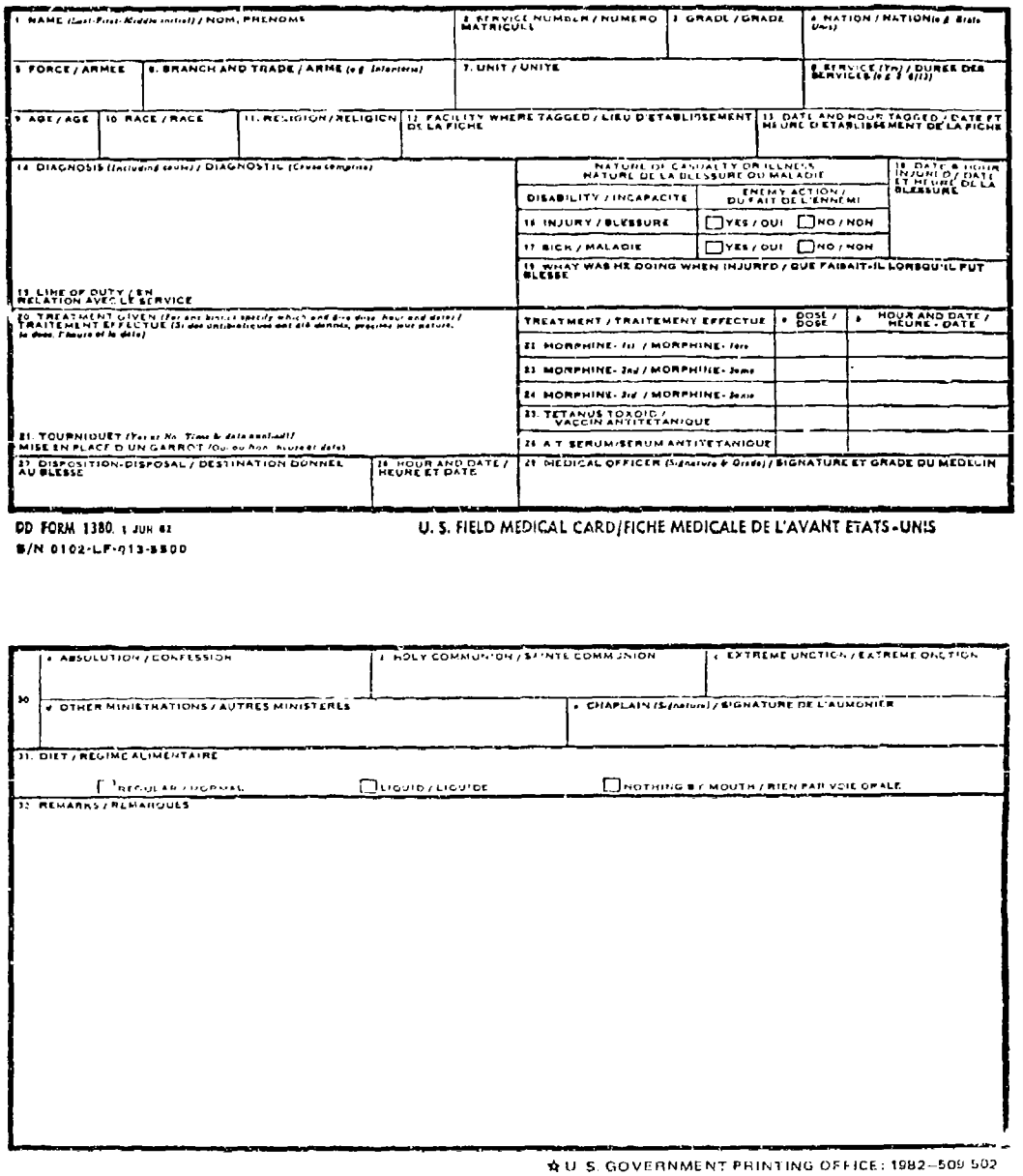
Alternatives to the U.S. Field Medical Card

LCDR Michael E. Congleton

Naval Health Research Center

San Diego, California

The collection of battle casualty information is important for medical, tactical, and research purposes. Since 1962 this information has been collected in the field (Echelon I) and at the Battalion Aid Station (Echelon II) with the U.S. Field Medical Card (Figure 1). As presently designed, this card has been



1. NAME (Last, First, Middle initial) / NOM, PRENOMS
2. SERVICE NUMBER / NUMERO MATRICULE
3. GRADE / GRADE
4. NATION / NATION (& State, Unit)
5. FORCE / ARMEE
6. BRANCH AND TRADE / ARME (e.g. Infantry)
7. UNIT / UNITE
8. SERVICE (Yrs) / DUREE DES SERVICES (e.g. 5 6/12)
9. AGE / AGE
10. RACE / RACE
11. RELIGION / RELIGION
12. FACILITY WHERE TAGGED / LIEU D'ETABLISSEMENT DE LA FICHE
13. DATE AND HOUR TAGGED / DATE ET HEURE D'ETABLISSEMENT DE LA FICHE
14. DIAGNOSIS (Including cause) / DIAGNOSTIC (Cause comprise)
NATURE OF CASUALTY OR ILLNESS / NATURE DE LA BLESSURE OU MALADIE
DISABILITY / INCAPACITE
ENEMY ACTION / DU FAIT DE L'ENNEMI
16. INJURY / BLESSURE ☐ YES / OUI ☐ NO / NON
17. SICK / MALADIE ☐ YES / OUI ☐ NO / NON
18. DATE & HOUR INJURED / DATE ET HEURE DE LA BLESSURE
19. WHAT WAS HE DOING WHEN INJURED / QUE FAISAIT-IL LORSQU'IL FUT BLESSE
15. LINE OF DUTY / EN RELATION AVEC LE SERVICE
20. TREATMENT GIVEN (Do not initial; specify which and give dose, hour and date) / TRAITEMENT EFFECTUE (Ne pas initialiser; spécifier lesquels ont été donnés, préciser leur nature, la dose, l'heure et la date)
TREATMENT / TRAITEMENT EFFECTUE
DOSE / DOSE
HOUR AND DATE / HEURE - DATE
21. MORPHINE - 1st / MORPHINE - 1ère
22. MORPHINE - 2nd / MORPHINE - 2ème
23. MORPHINE - 3rd / MORPHINE - 3ème
24. TETANUS TOXOID / VACCIN ANTITETANIQUE
25. TOURNIQUET (Yes or No. Time & date applied) / MISE EN PLACE D'UN GARROT (Oui ou Non. Heure et date)
26. A.T. SERUM/SERUM ANTITETANIQUE
27. DISPOSITION-DISPOSAL / DESTINATION DONNEE AU BLESSE
28. HOUR AND DATE / HEURE ET DATE
29. MEDICAL OFFICER (Signature & Grade) / SIGNATURE ET GRADE DU MEDECIN

DD FORM 1380, 1 JUN 82
S/N 0102-LF-013-8800

U. S. FIELD MEDICAL CARD/FICHE MEDICALE DE L'AVANT ETATS-UNIS

30. a. ABSOLUTION / CONFESSION
b. HOLY COMMUNION / SAINTE COMMUNION
c. EXTREME UNCTION / EXTREME ONCTION
d. OTHER MINISTRATIONS / AUTRES MINISTERES
e. CHAPLAIN (Signature) / SIGNATURE DE L'AUMONIER
31. DIET / REGIME ALIMENTAIRE
☐ REGULAR / ORDINAIRE ☐ LIQUID / LIQUIDE ☐ NOTHING BY MOUTH / RIEN PAR VOIE ORALE
32. REMARKS / REMARQUES

☆ U.S. GOVERNMENT PRINTING OFFICE: 1982—509 502

Figure 1. U.S. Field Medical Card

considered to be inadequate both in information requested and the ability to withstand climatic and physical conditions encountered in combat. As a continuous record of treatment, it has been perceived as too small and too difficult to read. Because of its size, it has been frequently lost or not included in medical records. Previous FMF workshops created committees to concentrate on problems encountered with the use of this card. These committees felt that the data collected at each echelon of the medical organization be confined to the minimal information necessary for the treatment of the patient at the next higher echelon. This restriction was imposed by the reality that only brief and readily obtained information could be collected by medical personnel working under the pressures of combat. The previous workshops stressed that the data provided by each echelon be sufficient to permit reconstruction of clinically important events in the patient's history. In September 1983, a working group convened at the Naval Health Research Center, San Diego, to consolidate the recommendations of the previous workshops concerning the minimal data required for Echelons I, II, and III. These elements included: (1) identification data, demographic data, brief medical history, presenting problems, vital signs, provider I.D., facility, injuries, procedures/treatments, medications, and final disposition from Echelon II, and (2) data requirements unique to Echelon III, triage disposition at Echelon III, laboratory tests, operative procedures, provider orders/notes, and final disposition from Echelon III (Appendix I, pp. 35-42).

A form was then designed by the Naval Health Research Center which contained elements to be recorded at Echelons I and II (Figure 2). It makes maximum use of checklists and body charts to record injuries and treatments. It is possible to print this form on mylar and thus make it virtually indestructable. The body charts could also be embossed to make their location in low light conditions easier. Side One of the form contains sections for recording basic demographic information, vital signs, Trauma Score, injuries, treatments, tubes, and anesthetics. Side Two includes sections for recording medications, triage classification, final disposition, and provider notes. In order to gain a better understanding of how this form could be used, examples of recording data from a simulated casualty will be reviewed as the casualty moves from Echelons I to III.

LAST NAME	FIRST NAME	M. I.	SOCIAL SECURITY NUMBER

PATIENT MANAGEMENT

TREATMENT FACILITY	FIELD CORPSMAN		BATTALION AID STA		MED/HOSP CO		FLEET HOSPITAL	
ARRIVED	Date	Time	Date	Time	Date	Time	Date	Time
TREATMENT	Date	Time	Date	Time	Date	Time	Date	Time

VITAL SIGNS

DATE	TIME	TEMP	PULSE	BLOOD PRESSURE SYS / DIAS	RESP RATE	RESP EXPAN	CAP REFILL	EYE OPEN	VERBAL RESPON	MOTOR RESPON
				( )/						
				( )/						
				( )/						

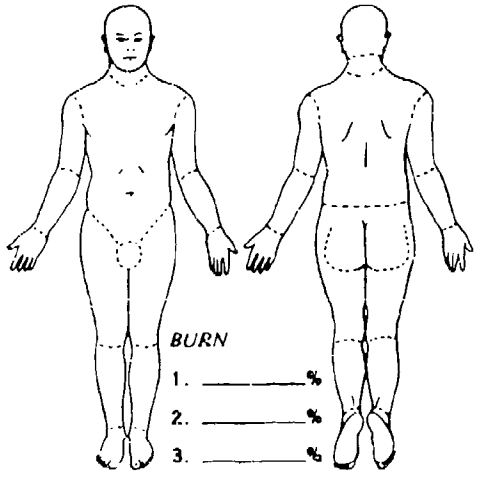
INJURIES

TYPE OF INJURY

1. DISLOCATION
2. FRACTURE
3. LACERATION
4. PUNCTURE
5. TRAUM AMPUTATION
6. WOUND
7. CONCUSSION
8. WHITE PHOS. BURN
9. OTHER BURN
10. OTHER (EXP.):

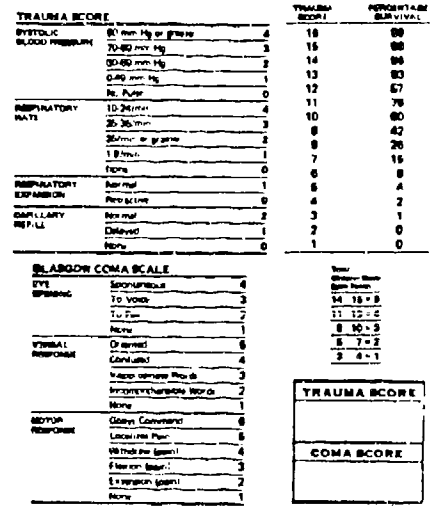
_____

_____



BURN

1. _____ %
2. _____ %
3. _____ %

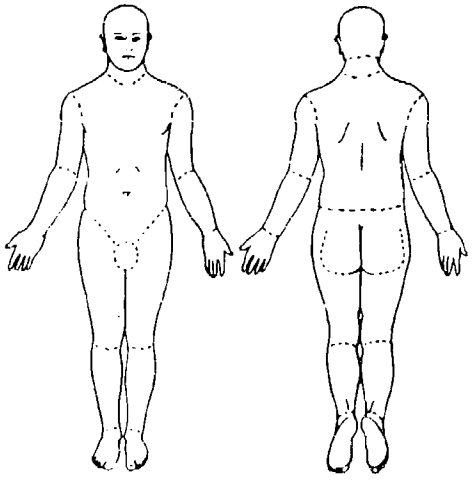


TREATMENTS

1. BANDAGE
2. TOURNIQUET
3. SPLINT
4. APPLY HEMOSTAT
5. TRACHEOTOMY
6. SUTURES
7. OXYGEN
8. DECONTAMINATION
9. CAST
10. OTHER:

_____

_____



TUBES

1. ENDOTRACH
2. CHEST
3. N G
4. FOLEY CATH

ANESTHETICS

REGIONAL

1. SADDLE BLOCK
2. EPIDURAL
3. AXILLARY
4. I V

FILLD

1. XYLOCAINE
   A. W/EPI
   B. W/O EPI

Figure 2

MEDICATIONS

	DATE	ROUTE PO/IM/IV/SUBQ	DATE	TIME	DATE	TIME	DATE	TIME
NARCOTICS MORPHINE OTHER								
SEDATIVES DIAZEPAM OTHER								
ANTIBIOTICS PENICILLIN TETRACYCLINE SULFA OTHER								
ANTIDOTE ATROPINE OTHER								
TOPICAL SPECIFY								
IMMUNIZATIONS TETANUS TOXOID VACCINE OTHER								
OTHER MEDICATIONS								
IV SOLUTIONS RINGERS NORMAL SAL D/W OTHER		GAUGE NEEDLE						

TRIAGE CLASSIFICATION

1. MINIMAL
2. DELAYED
3. URGENT
4. EXPECTANT

FINAL DISPOSITION

- ☐ RETURNED TO DUTY
- ☐ EVACUATED - MODE:
  - ☐ AIR
  - ☐ LAND
  - ☐ SEA
  - ☐ OTHER: _____
- ☐ DIED OF:
  - ☐ BATTLE INJ
  - ☐ NON-BATTLE INJURY
  - ☐ DISEASE
  - ☐ BURNS
  - ☐ SUICIDE
  - ☐ CHEM. AGENT
  - ☐ BIOLOGICAL AGENT
  - ☐ RAD. AGENT
  - ☐ OTHER: _____

PROVIDER NOTES

Figure 2 (Continued)

In combat situations the field corpsman must go to the casualty, many times while under enemy fire. When the casualty is located, the corpsman performs emergency first aid which could include the immobilization of fractures, the application of tourniquets to stop major bleeding in the extremities, bandaging wounds and burns, and the administration of analgesics and antibiotics. After completing emergency first aid, the corpsman fills out the form. Basic demographic data are recorded from the casualty's dog tag and, instead of taking time to write out descriptions of the injuries and treatments as required on the Field Medical Card, this form could be quickly marked to indicate the site and type of injury and site and type of treatment.

The casualty is then taken, by litter if necessary, to Echelon II the Battalion Aid Station.

At the Battalion Aid Station, the form is reviewed while the patient receives further treatment such as IV administration, tube placement, regional anesthetics, oxygen administration, wound debridement and closure, etc. Additional injuries can be identified and treated and the form updated. The Battalion Aid Station is equipped to take a complete set of vital signs, and a section associating vital signs to Trauma Score variables is included on Side One of the form. The resulting Trauma Score can then be used to derive the casualty's probability of survival. This might have use in assigning priorities to patients for evacuation. If the patient requires further treatment, he is evacuated to Echelon III--the Medical Company.

After arriving at the Medical Company, the patient is taken into the triage area where he is further examined. The form is reviewed, and the casualty is assigned a triage disposition of either minimal, delayed, urgent, or expectant. The Medical Company creates a permanent record, and the form becomes a part of that record to accompany the patient if further evacuation is necessary. At the Medical Company, data from the form could be input into a field-hardened microcomputer such as the Marine Corps Green Machine (IBM Series I). Information from further computer data processing could then be used to track personnel, make tactical decisions, and assess supply/resupply needs.

A second form was designed at the Naval Health Research Center to illustrate how data elements recorded by Echelons I, II, and III might be included

(Figure 3). Both forms are presented at this conference to illustrate alternatives to the current Field Medical Card. Subsequent recommendations made at this conference will be used to create a prototype version FMF card for future field testing.

NAME Last	First	M. I.	SOCIAL SECURITY NUMBER
INJURY CLASS ☐ 1. COMBAT ☐ 2. NON-COMBAT			TIME OF INJURY Date / Hour

PATIENT MANAGEMENT

TREATMENT FACILITY	FIELD CORPSMAN		BATTALION AID STATION		MEDICAL/HOSPITAL CO.		FLEET HOSPITAL	
ARRIVED	Date	Time	Date	Time	Date	Time	Date	Time
TREATMENT	Date	Time	Date	Time	Date	Time	Date	Time

PRESENTING PROBLEMS

☐ 1. PHYSICAL INJURY
☐ 2. PHYSICAL ILLNESS
☐ 3. PSYCHOLOGICAL PROBLEMS

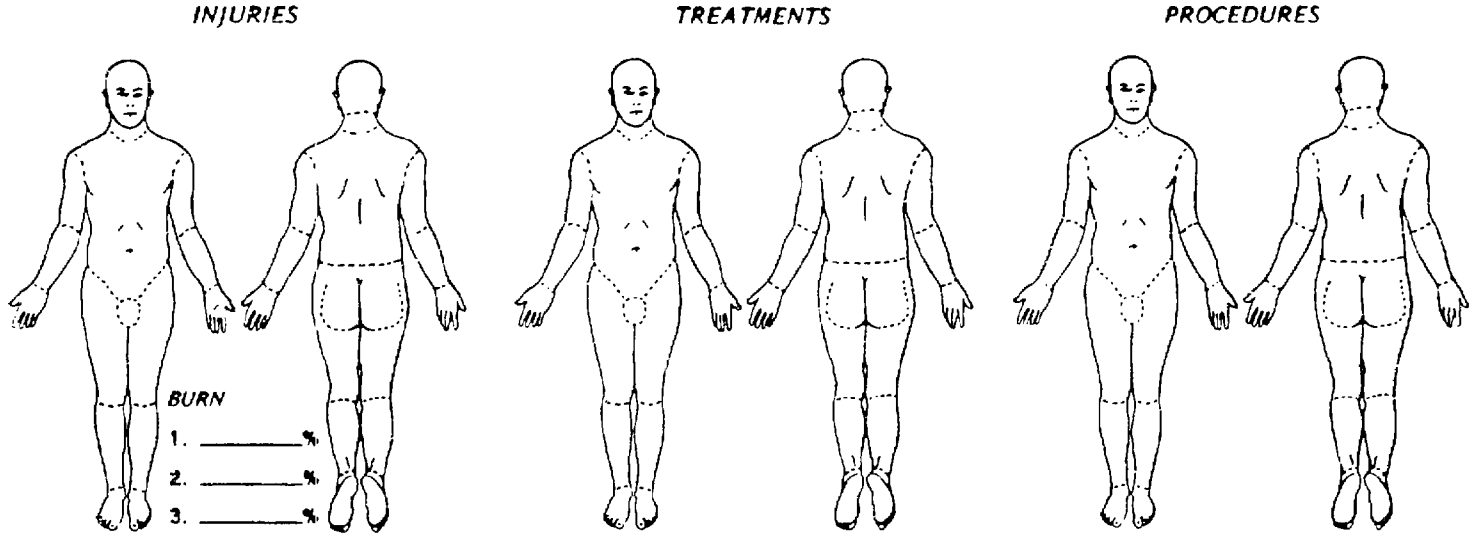
VITAL SIGNS

DATE	TIME	TEMP	BP SYS / DIAS	PULSE	RESP RATE	RESP EXPAN	VERBAL RESPON	EYE OPEN	MOTOR RESPON	CAP REFILL	TRAUMA SCORE
			/								
			/								
			/								
			/								

MEDICATIONS

	DOSE	ROUTE PO/IM/IV/SUBQ	DATE	TIME	DATE	TIME	DATE	TIME
NARCOTICS MORPHINE OTHER								
SEDATIVES DIAZEPAM OTHER								
ANTIBIOTICS PENICILLIN TETRACYCLINE SULFA OTHER								
ANTIDOTE ATROPINE OTHER								
TOPICAL SPECIFY								
IMMUNIZATIONS TETANUS TOXOID VACCINE OTHER								
OTHER MEDICATIONS								
I V SOLUTIONS RINGERS NORMAL SAL D5W OTHER		GAUGE NEEDLE						

Figure 3



TYPE OF INJURY
1. DISLOCATION
2. FRACTURE
3. LACERATION
4. PUNCTURE
5. TRAUM. AMPUTATION
6. WOUND
7. CONCUSSION
8. WHITE PHOS. BURN
9. OTHER BURN
10. OTHER INJ:_____

TUBES
- ☐ ENDOTRACH
- ☐ CHEST
- ☐ N G
- ☐ FOLEY CATH

TREATMENTS
1. BANDAGE
2. TOURNIQUET
3. SPLINT
4. APPLY HEMOSTAT
5. TRACHEOTOMY
6. SUTURES
7. OXYGEN
8. DECONTAMINATION
9. CAST
10. OTHER:_____

ANESTHETICS

REGIONAL	FIELD
☐ SADDLE BLK	
☐ EPIDURAL	W/EPI
☐ AXILLARY	W/O EPI
☐ I V	

OPERATIVE PROCEDURES
1. REPAIR
2. DEBRIDE
3. EXCISE
4. AMPUTATE
5. OTHER:_____

PROVIDER NOTES

TRIAGE CLASSIFICATION
1. MINIMAL
2. DELAYED
3. URGENT
4. EXPECTANT

FINAL DISPOSITION
- ☐ RETURNED TO DUTY
- ☐ EVACUATED - MODE:
  - ☐ AIR
  - ☐ LAND
  - ☐ SEA
- ☐ OTHER:_____
- ☐ DIED OF:
  - ☐ BATTLE INJ
  - ☐ NON-BATTLE INJURY
  - ☐ DISEASE
  - ☐ BURNS
  - ☐ SUICIDE
  - ☐ CHEM. AGENT
  - ☐ BIOLOGICAL AGENT
  - ☐ RAD. AGENT
  - ☐ OTHER:_____

Figure 3 (Continued)

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Identification Data				
Name	Recorded on Data Tag	Required Information	Required Information	Required Information
SSN/Family Member Prefix		Required Information	Required Information	Required Information
Date of Birth		Optional Information	Optional Information	Optional Information
Sex		Optional Information	Optional Information	Optional Information
Demographic Data				
Paygrade or Rank	Recorded on Data Tag	Optional Information	Optional Information	Optional Information
Country				
Branch of Service				
Race				
Religion				
Brief Medical History				
Allergies (Most Recent)	Recorded on Data Tag	Required Information	Required Information	Required Information
Blood Type		Optional Information	Optional Information	Required Information
Immunization Status (Smallpox, Typhoid, Tetanus, Cholera, Yellow Fever, Plague, Polio, Influenza)		Optional Information	Optional Information	Optional Information
Heart Irregularity		Required Information	Required Information	Required Information
Unequal Pupils Normal		Required Information	Required Information	Required Information
Presenting Problems				
Problem List			Problem List Recorded	Problem List Recorded Chart of Body Parts and Organs Marked as to What and Where
Provider I. D.			Recorded	Recorded
Facility No.			Recorded	Recorded

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Vital Signs				
Temperature			Repeated Measurements Recorded Along with Time *(Date/Hour/Min.)*	Repeated Measurements Recorded Along with Time *(Date/Hour/Min.)*
Pulse			↓	↓
Respiratory Rate			Not Measured at Echelon II	
Respiratory Effort (Expansion)			Repeated Measurements Recorded Along with Time *(Date/Hour/Min.)*	
Systolic Blood Pressure			↓	↓
Diastolic Blood Pressure				
Verbal Response: 1. Oriented 2. Confused 3. Inappropriate Words 4. Nonunderstandable 5. None				
Eye Opening: 1. Spontaneous 2. To Voice 3. To Pain 4. None				
Motor Response: 1. Obeys Commands 2. Withdrawal 3. Flexion 4. Extension 5. None				
Capillary Refill: 1. Less than 2 Seconds 2. 2 Seconds or Greater				
Mental Status Exam		Abbreviated Exam Recorded Recorded Along with Time *(Date/Hour/Min.)*	*Further Description Recorded* Repeated Measurements Recorded Along with Time *(Date/Hour/Min.)*	Mental Status Exam Recorded Repeated Measurements Recorded Along with Time *(Date/Hour/Min.)*
Glasgow Coma Scale: Scale Trauma Score/Probability of Survival			Optional Measurement	Recorded
Triage Category: 1. Minimal 2. Delayed 3. Immediate 4. Expectant				
Provider I. D.		Recorded	Recorded	Recorded
Facility No.			Recorded	Recorded

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Injuries				
Time of Injury *(Date/Hour)*		Recorded	Further Description Recorded	Further Description Recorded
Body Part		↓	↓	↓
Type of Injury:				
Dislocation				
Fracture				
Laceration				
Puncture				
Traumatic Amputation				
Wound				
Burns: 3°____ 2°____ 1°____				
% of Body Area				
Procedures/Treatments				
Tourniquet		Time *(Date/Hour/Min.)* Applied and Removed Recorded	Time *(Date/Hour/Min.)* Applied and Removed Recorded	Time *(Date/Hour/Min.)* Applied and Removed Recorded
Splints		Type and Location Recorded	Type and Location Recorded	Type and Location Recorded
Bandages		Recorded	Recorded	Recorded
Tracheotomy		Recorded	Recorded	Recorded
Tubes *(Endotracheal, Chest, NG, Foley Catheter)*			Type Recorded	Type Recorded
Casting/Immobilization:			Recorded	Recorded
Body Part				
Method				
IV Solutions:			Recorded	Recorded
Ringers Lactate				
Normal Saline				
D5W				
Other *(Specify)*				
Time Started				
Location				
Gauge Needle				
Sutures			Recorded	Recorded
Oxygen Administration:			Recorded	Recorded
Time Started			↓	↓
%				

COMBAT MEDICAL RECORD

DATA ELEMENTS	*IN GARRISON*	*ECHELONS*		
		ECHELON I	*ECHELON II (BAS)*	*ECHELON III*
Medications Narcotics: Morphine Antibiotics: Penicillin Sulfa Antidotes: Atropine Immunizations: Tetanus: Toxoid Vaccine Serum Other *(Specify)* Route of Administration Provider I. D. Facility No. Anti-arrhythmics Pre-op Medications		Recorded (Dose and Times [Date/Hour/Min.])	Recorded (Dose and Times [Date/Hour/Min.])	Recorded (Dose and Times [Date/Hour/Min.])

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Final Disposition from Echelon II				
Treated and Returned to Field			Recorded	
Evacuated by:			↓	
Air				
Boat				
Field Litter				
Ambulance				
Died of Wounds				
Other *(Specify)*				
Medical Officer I. D.				
Facility No.				

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Patient Management at Echelon III				
Received by:				Recorded
Air				↓
Boat				
Field Litter				
Ambulance				
Time of Arrival				
Time Seen				
Time into OR				
Facility No.				
Triage Disposition at Echelon III				
Morgue				Recorded
X-ray				↓
OR (Major Surgery)				
OR (Minor Surgery)				
ICU				
Decontamination Treatment				
Primary Ward				
Overflow Ward				
Triage Medical Officer I. D.				
Facility No.				

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Operative Procedure				
Time *(Date/Hour/Min.)*				*Recorded*
Type of Procedure:				
R - Repair				
D - Debride				
X - Excise				
P - Amputate				
O - Other *(Specify)*				
Chart of Body Parts and Organs Marked for Location of Procedure				
Anesthetic Type:				
GENERAL				
H - Halothane				
E - Ether				
N - Nitrous Oxide				
REGIONAL				
SAB - Saddle Block				
EPDL - Epidural				
AX - Axillary				
IV - Intravenous				
FIELD				
Xylocaine:				
With epinephrine				
Without epinephrine				
Pontocaine				
Administration Time *(Date/Hour/Min.)*				
Special Procedures *(Text)*				
Remarks *(Text)*				
Intensive Care:				
Time *(Date/Hour/Min.)*				
Summary *(Text)*				
Medical Officer I. D.				
Surgeon I. D.				
Facility No.				

COMBAT MEDICAL RECORD

DATA ELEMENTS	IN GARRISON	ECHELONS		
		ECHELON I	ECHELON II (BAS)	ECHELON III
Provider Orders/Notes				
Orders				Recorded
Provider I. D.				↓
Notes				
Provider I. D.				
Summary (Text)				
Facility No.				
Final Disposition from Echelon III				
Treated and Returned to Field				Recorded
Evacuated by:				↓
Air Vehicle				
Land Vehicle				
Sea Vehicle				
Died of:				
Battle Injuries				
Non-Battle Injuries				
Burns				
Chemical Agent				
Disease				
Suicide				
Other *(Specify)*				
Medical Officer I. D.				
Facility No.				

Implementation of Severity Scores in Naval Casualty Care

William J. Sacco, Ph.D.

Cyometrics, Inc.

Bel Air, Maryland

This presentation is a discussion of injury severity indices and applications to combat casualty management. The applications include the characterization of casualty conditions from the scene of wounding through the intensive care unit, casualty prognosis and triage, simple communication of injury severities of mass casualties, assessment of therapeutic modalities, and evaluation of care in general.

The indices are the Trauma Score (or simpler variants), the Global Index, and the Injury Severity Score. The Trauma Score is based on assessments of physiological responses soon after injury. The Global Index characterizes patient condition in the Intensive Care Unit using measures of organ function. The Injury Severity Score is a measure based on injury descriptions in terms of anatomical lesions.

Background

Trauma Score

The Trauma Score (1) is a physiological measure of injury severity. It is based on seven cardio-respiratory-neurological assessments easily obtained by doctors, nurses, or corpsmen.

The seven assessments are:

respiratory rate

respiratory expansion

capillary refill

systolic blood pressure

eye opening

best verbal response

best motor response

The Trauma Score is developed from these assessments as shown in Table 1. Eye opening, best verbal response, and best motor response make up the Glasgow Coma Scale (2), used worldwide to assess central nervous system function.

TABLE 1

TRAUMA SCORE
CATEGORY DEFINITIONS, METHODS OF ASSESSMENT, AND CODES

		Rate	Codes	Score
A.	Respiratory Rate	10-24	4	
	Number of respirations in 15 seconds;	25-35	3	
	multiply by four	36 or greater	2	
		1- 9	1	
		0	0	A.___
B.	Respiratory Expansion			
	Normal	Normal	1	
	Retractive- Use of accessory muscles	Retractive	0	B.___
C.	Systolic Blood Pressure	90 or greater	4	
	Systolic cuff pressure- either arm,	70-89	3	
	by ausculation or palpation	50-69	2	
		1-49	1	
	No pulse	0	0	C.___
D.	Capillary Refill			
	Normal- Nail bed color refill in 2 seconds	Normal	2	
	Delayed- More than 2 seconds capillary refill	Delayed	1	
	None- No capillary refill	None	0	D.___

			Total GCS Points	Score
E.	Glasgow Coma Scale			
	1. Eye Opening			
	Spontaneous	___4	14-15	5
	To Voice	___3	11-13	4
	To Pain	___2	8-10	3
	None	___1	5- 7	2
			3- 4	1 E.___
	2. Best Verbal Response			
	Oriented	___5		
	Confused	___4		
	Inappropriate Words	___3		
	Incomprehensible Sounds	___2		
	None	___1		
	3. Best Motor Response			
	Obeys Commands	___6		
	Localizes pain	___5		
	Withdraw (pain)	___4		
	Flexion (pain)	___3		
	Extension (pain)	___2		
	None	___1		

Total GCS Point (1+2+3) _____

TRAUMA SCORE____
(Total Points A+B+C+D+E)

A previous study (3,4) evaluated the Trauma Score as a possible adjunct to casualty assessment and triage in the early stage of combat care. Results showed that the corpsmen were capable of doing the clinical assessments required by the Trauma Score with minimal training, and their facility and accuracy improved with repetitive drills and practice on simulated casualties. In the study several simpler variants of the Trauma Score were also evaluated using data from 888 patients with penetrating injuries. One version, called RECG, uses all Trauma Score variables except systolic blood pressure, which is rarely obtained by corpsmen in the field. Another version, called RPM, incorporates three variables only--respiratory rate, pulse rate, and best motor response. Both RECG and RPM are good predictors of patient outcome, about 90% as powerful as the Trauma Score. They are easier to memorize, require less time for assessments, and have potential for use at all echelons of care including use by corpsmen at the scene of wounding. During the study the concept was presented to Navy corpsmen, medical school staff, medical officers, and health care officials. They found it compelling because of its simplicity, power, and application at all echelons of care to triage, to characterization of patient state over time from the scene of wounding to the definitive care facility, and potential for immediate feedback to lower echelons on the quality of casualty triage and management.

The power, validity, and usefulness of a physiological severity score, such as the Trauma Score, RECG, or RPM, can be enhanced substantially by two refinements: decomposing the score into two components, a respiratory-circulatory component and a neurological component; and separate analyses of patients with and without serious head wounds (5). Such decompositions are available for the Trauma Score, RECG, and RPM. For example, the index pair (C_n, R_n), is the decomposition of the Trauma Score into a central nervous system part C_n and a respiratory-circulatory part R_n. Using the notation of Table 1, $C_n = E$ and $R_n = A + B + C + D$.

Global Index

The factors included in the Global Index are the Respiratory Index, serum creatinine, serum bilirubin, and the Glasgow Coma Scale. The Respiratory Index (6,7) was developed to measure post-traumatic pulmonary problems and can be used

as a guide for respiratory therapy. The Global Index is an overall measure of patient morbidity derived from the statistically most powerful measurements among several respiratory, renal, hepatic, and central nervous system variables (8). It can be used to track patients in the Intensive Care Unit and for assessment of therapy and patient care (9,10,11). It is computed as follows:

$$\text{Global Index} = R_n + C_n + B_n + G_n$$

where

R_n = 1.5 x Respiratory Index;

C_n = 0 if Serum Creatinine is one or less or

= 2.0 x (Serum Creatinine - 1.0) if Serum Creatinine is greater than one

B_n = 0.5 x Serum Bilirubin;

G_n = 15.0 - Glasgow Coma Scale.

The four variables defined above also appear in other indices called Clinical Hulls, defined in a later paragraph.

The Respiratory Index (RI), a measure of respiratory insufficiency, is defined as follows:

$$RI = \frac{713F_{IO}{}^2 - P_aCO_2 - P_aO_2}{P_aO_2}$$

where

$F_{IO}{}^2$ = tractional concentration of O_2 in inspired gas

P_aO_2 = arterial partial pressure of oxygen (mm Hg)

P_aCO_2 = arterial partial pressure of carbon dioxide (mm Hg)

For the Navy application the Global Index could be used in the definitive care facility to complete the tracking of a casualty. The Trauma Score or simpler variant, together with the Global Index, would provide a permanent record of patient condition transitions, from the injury scene through the ICU, with implications for triage, evaluation of care in general, and evaluation of specific therapeutic modalities at all echelons of care. The applications will be described in more detail in a later section.

Injury Severity Score

The Injury Severity Score (ISS) (12) is based on an earlier development, the Abbreviated Injury Scale (AIS)(13), which in turn is based on a listing of lesion descriptions. Each lesion is assigned a severity code from one (for minor injuries) to six (for injuries that are untreatable and always fatal, for example, traumatic decapitation). The ISS relies on AIS codes for six body regions: (1) head and neck, (2) face, (3) chest, (4) abdominal and pelvic contents, (5) extremities and pelvic girdle, and (6) external.

If a victim has any injury with an AIS value of six, the ISS is assigned a value of 75. Otherwise, the ISS is computed as the sum of the squares of the three highest AIS codes from three different body regions. For example, suppose a victim has seven injuries distributed as follows:

Region	Number of Injuries	AIS Codes
1	2	5,4
2	0	0
3	2	3,2
4	1	2
5	1	4
6	1	1

In this example the three highest values for three different regions are 5 (from region 1), 3 (from region 3), and 4 (from region 5).

The ISS = $5x5 + 3x3 + 4x4 = 25 + 9 + 16 = 50$.

Because the ISS is defined as 75 for cases where any AIS = 6, the ISS can reach no value higher than $3 \times 5 \times 5 = 75$, and its range is therefore from 1 to 75; the higher the score, the graver the patient's condition.

Application to Management of Combat Casualties

Here we discuss applications of the indices to the triage, tracking, and evaluation of management of casualties.

Triage Principles Incorporating a Physiological Response Score

Triage is a method of managing mass casualties, including assessment and classification of casualties, for priorities of treatment and evacuation. In a wartime mass casualty situation, the priorities of treatment and evacuation are

dependent obviously on military objectives. The priorities can be radically different for different objectives.

The triage principles discussed here, which implement physiological response scores, are intended to maximize survivors. As such, these principles would be appropriate after other higher priority objectives (if any) had been addressed.

By definition, in a mass casualty situation, resources are not available for meeting the needs of all casualties over a short period of time. Hence triage is used to sequence patient care. If the objective is to maximize survivors, establishing urgency is the first sorting criterion.

The battalion aid station is the primary site of casualty sorting. Under some current military protocols, casualties are examined by the battalion aid station medical officer or assistants. The medical officer determines the level of treatment required and the priority of evacuation.

All casualties are classified by level of treatment required. There are four classification groups, called minimal, delayed, immediate, or expectant, defined as follows:

1) Minimal: Those casualties whose injuries are so slight that they can be managed by self-help or buddy care and who can be returned promptly to their units for full duty.

2) Delayed: Those casualties whose wounds require medical care but are so slight that they can be managed by the battalion aid station or in the amphibious objective area and who can be returned to duty after being held for only a brief period.

3) Immediate: Those casualties whose conditions indicate the need for immediate resuscitation and usually surgery.

4) Expectant: Those casualties that have low chances of survival even if accorded full medical resources.

Triage in the field involves priorities for care in the field and for evacuation to higher echelons of care. Casualties may be triaged many times in the field. Frequency will depend upon such factors as the intensity of combat and availability of time and resources for resuscitation, treatment, or evacuation, or for more definitive assessment and treatment.

In such circumstances, serial measurements of a physiological response score can help provide a finer discrimination of patients in Categories 3 and 4 at various stages of triage and care. For example:

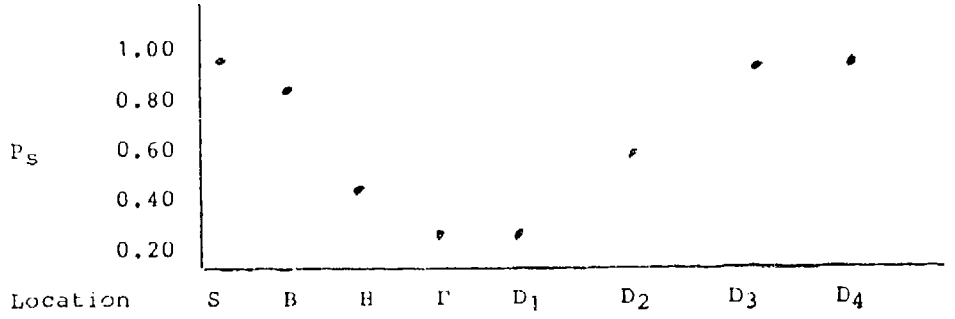
1. Each patient in Categories 3 and 4 can be assigned a probability of survival, P_S, associated with the response score. The P_S is to be interpreted as the probability of survival presuming immediate definitive care.
2. Serial assessments can be used to measure the clinical "change of state" of a casualty:
   a. From scene of wounding to Battalion Aid Station (BAS).
   b. Awaiting resuscitation therapy at the BAS.
   c. Before and after resuscitation at the BAS.
   d. In the holding area at or near the BAS.
   e. During evacuation.
   f. Awaiting additional care in the field hospital.

The serial scores would provide evidence of casualty deterioration, stability, or improvement.

Patient Tracking

The Trauma Score and Global Index can provide a permanent record of patient condition transitions from the injury scene through the ICU, with implications for triage, evaluation of care in general, and evaluation of specific therapeutic modalities at all echelons of care.

One of the simplest methods for tracking the progress of a casualty is a time series plot of the survival probability P_s, illustrated for a hypothetical patient in the figure below,



The symbols on the horizontal axis are defined as follows:

S: Scene of injury

B: Battalion Aid Station

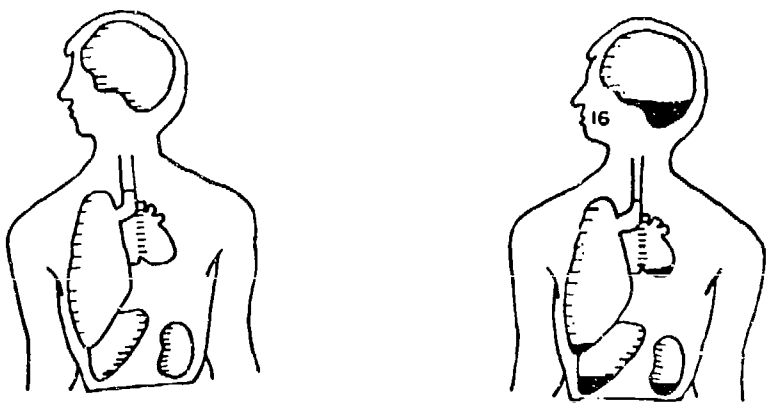
H: Holding Area

F: Field Hospital

D_i: Definitive Care Facility (Admission and three succeeding days)

In the construction of such a chart, the probability of survival estimates for S, B, H, and F are based on a simple score (Trauma Score or variant) and those for D_i are based on the Global Index.

In addition, we can provide a graphical presentation of the ICU record by means of "anatoglyphs", like the diagram shown below (14,15).



In these anatoglyphs, the five body regions of greatest physiological importance (the brain, heart*, kidney, lungs, and liver) are outlined with scale markings. Shading these five areas to a height corresponding to the severity of the individual organ's derangement gives an anatoglyph of the patient's condition. An example is shown on the right above.

Clinical hull anatoglyphs are of two kinds. These hulls are devices to capture the worst or best condition of the patients in a single glyph. The

---

*Although the heart is included here, this version of the Global Index does not contain cardiovascular variables. The number appearing near the mouth of the profile is the Global Index. A series of daily anatoglyphs transforms the patient's charts into a picture sequence that can be read at a glance.

hulls change from day to day in the intensive care unit. On any given day, the outer hull anatoglyph will display each organ outline shaded up to the highest level that shading has reached on any day to date, thus representing the worst condition seen so far. The inner hull shows each organ outline shaded only to the lowest level to date, thus representing the best condition so far.

Evaluation of Care

Here we present a two-phase approach to evaluation of patient care (10,11). The first level, called PRE (from PREliminary), identifies unexpected survivors and deaths. These cases may be therapeutic triumphs or failures. PRE can be used to assess patient management at any echelon.

The second level, the State Transition Screen or STS, identifies patients with unusual clinical courses in the definitive care unit. Among these are patients who improve substantially before they die, and patients who deteriorate substantially before they recover. These cases may be near triumphs or near failures.

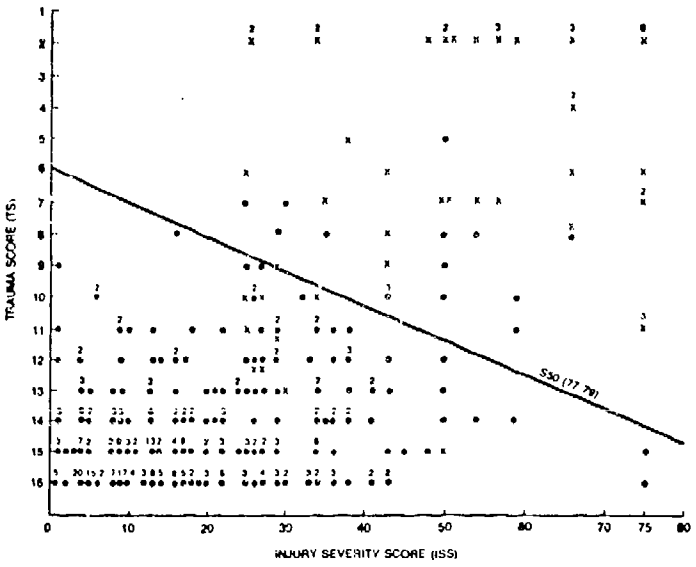
PRE: Semi-Quantitative Assessment of Trauma Care. Ideally the basic ingredients of the PRE methodology are two injury severity scales, one anatomical the other physiological. The goal of PRE is to identify cases where the outcome was anomalous--in terms of the scales employed.

In the discussion here, we use the Trauma Score as the physiological assessment and the Injury Severity Score as the anatomical assessment. The scores are ploted on an x-y graph as in Figure 1. For example, a patient with an ISS of 25 and a TS of 13 is represented by an x or a dot at coordinates 25, 13. The dots are survivors and the x's, deaths. Multiple occurrences at the same coordinates are indicated by a number near the symbol.

On such a plot, whatever the scales employed, survivors usually predominate toward one corner of the plot, deaths at the opposite corner; and mixed results are seen along a sloping line that cuts across the connecting diagonal. Such is the case in Figure 1, where survivors predominate at the lower left and deaths at the upper right. The sloping line in Figure 1 is called the 50 isobar. At each point on this line, the patient has a 50 percent chance of survival. A patient whose point is below the line in this figure has better than a 50 percent chance of survival, and in a statistical sense, is expected to survive.

Washington Hospital Center Shock Trauma Patients

1980-1981 BLUNT TRAUMA PATIENTS



Trauma Scores versus Injury Severity Scores
Figure 1

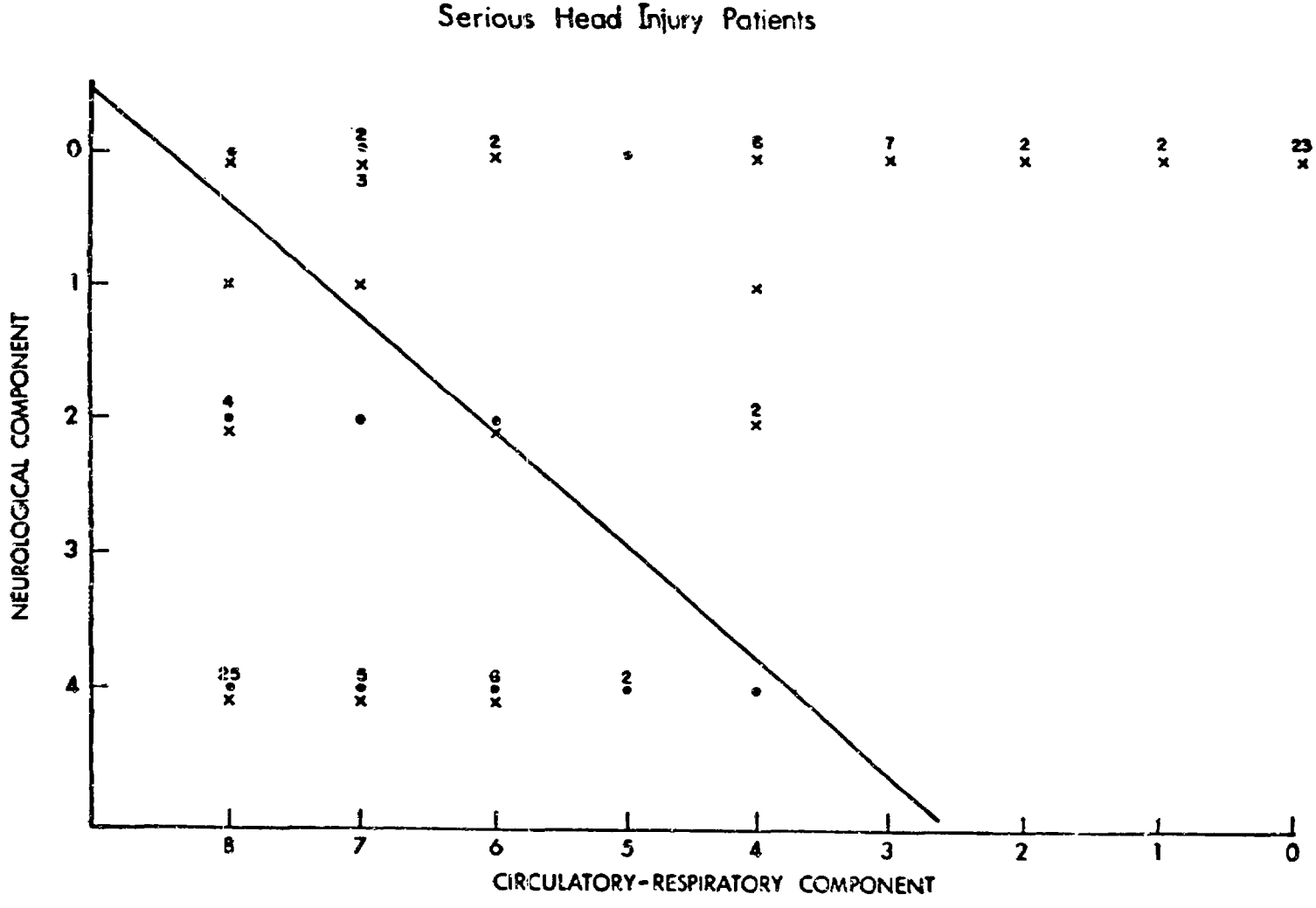
The survivors whose points are above the line and the nonsurvivors below the line are the patients sought to be identified by PRE: those with anomalous or "unexpected" outcomes. These are cases worthy of audit.

The data in Figure 1 are from a set of 402 blunt trauma patients seen at the Washington Hospital Center (Washington, D.C.) from January 1, 1980 to December 31, 1981. The S50 isobar in the figure was computed from earlier data. This combination--of current data and historic isobar--illustrates the usual implementation of PRE. In practice, a patient's (ISS, TS) pair is plotted as soon as his or her data are available, and the decision whether the patient outcome was unexpected (in a statistical sense) is based on an isobar from previous data. PRE can also be implemented with two-component physiological scores. These pairs are nearly as powerful as the physiological-anatomical pairs. The patient can be represented as soon as the measures are obtained. One need not wait for an anatomical assessment. Figure 2 is an example for a two-component pair applied to serious head-injured patients.

State Transition Screen (STS). The cases cited by PRE are not the only ones that are interesting and deserving of audit. Other interesting cases are those whose admission scores to definitive care facility indicate a better than 50 percent chance of survival, but who deteriorate substantially before they recover; and those whose admission scores indicate a low probability of survival, but who improve substantially before they die. To sift out these cases, we need measures of patient condition, and criteria for distinguishing major from minor fluctuations.

The survival probabilities needed are the admission value (P_A) and daily values in the ICU. The admission value can be based on a Trauma Score-ISS combination or a two-component physiological score, and the ICU values can be based on the Global Index.

The audit selection criteria in STS are different for survivors and non-survivors. The survivors selected are those for whom P_A is greater than 0.50, but whose survival probability falls below P_A by 0.25 or more during the ICU stay. The non survivors selected are those for whom P_A is 0.50 or less, but whose Global Index reaches 10 or less during the ICU stay.



Physiological Pair of Assessments

Figure 2

REFERENCES

1. Champion H, et al. Trauma Score. Crit Care Med 9:672-676, 1981.
2. Teasdale G, Jennett B. Assessment of Coma and Impaired Consciousness: A Practical Scale. Lancet 2:81, 1974.
3. Sacco W, Champion H, Morelli S. The Role of the Trauma Score in Triage of Mass Casualties and Evaluation of Patient Care. Proceedings of the Fifteenth Hawaii International Conference on System Sciences. Honolulu, 1982.
4. Sacco W, et al. Testing of Navy Corpsmen in Trauma Score Assessment. Proceedings of the Sixteenth Hawaii International Conference on System Sciences. Honolulu, 1983.
5. Sacco W, Champion H, Henderson J. Implementation of Severity Scores in Naval Casualty Care. Proceedings of Seventeenth Hawaii International Conference in System Sciences. Honolulu, 1984.
6. Goldfarb M, Sacco W, Ciurej T, et al. Tracking Respiratory Therapy in the Trauma Patient, Am J Surg., 129:255-258, 1975.
7. Goldfarb M, Sacco W, Weinstein M. Two Prognostic Indices for the Trauma Patient. Comput Biol Med, 7:21-25, 1977.
8. Sacco W, Champion H, Stega M. Trauma Care Evaluation. University Park Press, 1984.
9. Champion H, Sacco W. Trauma Risk Assessment: Review of Severity Scales. Emergency Medical Manual, Appleton-Century-Crofts, 1983.
10. Champion H, Sacco W, Hunt T. Trauma Severity Scoring to Predict Mortality. World J Surg. 7:4-11, 1983.
11. Sacco W, Champion H. Trauma Injury Severity Scales. Current Emergency Therapy, Appleton-Century-Crofts, 1984.
12. Baker S, O'Neill B, Haddon W, Long W. Injury Severity Score: A Method for Describing Patients with Multiple Injuries and Evaluating Emergency Care. Trauma 14:187-196, 1974.
13. Committee on Medical Aspects of Automative Safety. Rating the Severity of Tissue Damage: The Abbreviated Injury Scale, JAMA 215:277-280, 1971.

14. Sacco W, et al. Use of Glyphs in Tracking Patients. Proceedings of the Fourteenth Hawaii International Conference on System Sciences, Honolulu, 1981.

15. Sacco W, et al. Glyphs Getting the Picture. The Science Teacher, 51-53.

Applications of a Computer-Based Patient Management System to Fleet Marine Force Medical Care

George Moeller, Ph.D.
Naval Submarine Medical Research Laboratory
Groton, Connecticut

This report describes a computer-based patient management system that serves as a medical consultant to corpsmen on-board submarines. It also shows how the patient management system is relevant to medical information management in the Fleet Marine Force. In addition, the implications of the lessons learned in development and implementation of the submarine system for the delivery of medical care in the Fleet Marine Force are discussed.

There are some differences between medical practice in the Submarine Forces and in the Fleet Marine Force. In submarines total responsibility for care of any ill or injured crew member may rest on the corpsman for days or weeks, even in peace time. For this reason an Independent Duty Submarine Corpsman (8402) is more highly trained and more experienced than the rifle company corpsman in the FMF. The second major difference implied by the preceding points is that the final level of care given by an 8402 is higher than that given by a corpsman in the FMF. As a consequence of these two differences, some computer-based aids provided to the submarine corpsman would be targeted at the battalion aid station or higher in the FMF context. There is a third difference that should be recognized but not over-emphasized, namely, the relative incidence of cases presenting as trauma and disease. While the relative incidence of trauma and disease should not change greatly aboard a submarine between war and peace, in the FMF, trauma cases will predominate in the first phase of an amphibious operation. However, Disease and Non-Battle Injuries (DNBI) will become more important sources of attrition in the FMF as time passes and units rotate between line and reserve status.

The objectives of the submarine system are paralleled in the Fleet Marine Force. The first is to improve patient care. The second is to minimize both temporary and permanent loss of manpower. The latter goals can be achieved by returning personnel to duty from the lowest level in the medical care system at

which definitive care can be rendered. With properly designed computer-based aids, it may be possible for the company corpsman to do more than he has been asked to do in the past.

Table 1

AREAS UNDER STUDY

ABDOMINAL PAIN	CHEST PAIN	PSYCHIATRIC CRISES
DENTAL EMERGENCIES	ORTHOPEDIC PROBLEMS	SHIPBOARD TRAUMA

Priorities for study were assigned to the areas named in Table 1 on the basis of observed incidences of, or reported causes for, evacuation. Work began with abdominal pain because the principal single cause for evacuation from submarines has been apparent appendicitis. The second disorder area taken for study was chest pain with major concern being for diagnosis and treatment of MI. The third kind of disorder that has contributed often to unnecessary evacuation has been psychiatric crises, some being seen as physical problems. The system under development will deal only with psychiatric crises, helping the corpsman discriminate between major and minor problems and guiding him in patient management. Dental emergencies have always been a problem aboard submarines because training in handling them is limited. The facilities consist of a kit designed and selected by dental authorities on the assumption that treatment normally would be palliative. The last two areas, orthopedic problems and shipboard trauma, are to be attacked because the corpsman needs help with them. Trauma is clearly an area in which NHRC has made a good start with the work described by Dr. Sacco. Work started in the orthopedic area some time ago when an orthopedic surgeon came on-board NSMRL for his reserve tour.

What has been achieved to date? NSMRL research began with an analysis of the corpsman's duties and the medical problems he encountered on patrol.

Following that analysis, a comprehensive review of the literature identified those programs which existed and seemed to be relevant. The one program that looked promising because it had been studied extensively in hospital settings was that developed by deDombal for diagnosis of abdominal pain. That program provided both a method for deriving a diagnosis, or algorithm, and a first draft of a database. With adaptation of the program to the Tektronix computer abroad the submarine and acquisition of a database appropriate to the submarine population, user evaluations could begin. Evaluation of corpsman use of computer-based patient management systems began with a series of studies asking: What kinds of data can the corpsmen collect reliably; can we teach him how to use this system; can we teach him how to use the computer; what problems, if any, does he encounter; and so on. In these studies it was more important to know how a corpsman reached a decision than whether it was right or wrong. Given the relatively high incidence of nonserious illnesses, you could do very well in a probabilistic sense if you diagnosed every case of abdominal pain, for example, as nonspecific abdominal pain. For that reason, we conducted observational studies in which one or two persons trained for that purpose observed the corpsman, usually in a clinical setting, as he applied the system to real life patients. Next, we conducted preliminary sea trials with the abdominal pain system to determine whether the corpsman could indeed use the system in the way intended. Although some corpsmen were unenthusiastic before they went to sea, on return they were all willing to grant that the system could be useful to them. The other important point about the sea trials is that by training the corpsmen to provide detailed records, and the specifics of each of these disorders as they present, we have greatly strengthened the possibility for effective communication between the corpsmen and the commanding officers. With the conclusion of the preliminary sea trials, the final versions of the programs and documentation were prepared. Then the operational trials of the abdominal pain were begun. Recently the first interim report on operational experience with that system was published. To date the system has worked reasonably well. When it has missed, it has missed for a reason that we had warned the corpsmen about--that the disorders which presented were outside the scope of the system.

In these cases, his independent diagnosis tells us the corpsman knew the disease was not within the domain of the program, but he wanted to test the system.

Sometime before the sea trials had begun, work on chest pain had been initiated. The original chest pain program did not include ECG. Since that time, there has been a shift in medical opinion so that now there is a consensus among Submarine Medical Officers favoring placement of ECG capability aboard the submarine. The second development came from a test in Brigham and Women's Hospital, Boston, of the initial chest pain program. There the original chest pain program without ECG performed about as well as a competing program developed at Brigham that did include ECG, but neither of them reached the level of accuracy needed to deploy the system to sea. Consequently, the chest pain program is being revised to incorporate ECG data. The ECG to be acquired is a miniaturized update and modification of the Computer Assisted Practice of Cardiology (CAPOC) system that will give the corpsman a fair amount of guidance with respect to the meaning of the ECGs. This kind of product could be very useful in the FMF medical system if used as the full scale CAPOC system is to preserve the precious time of the physicians at level II or beyond.

Where are we now? Studies have been conducted at the Naval Hospital, Groton of the ability of corpsmen to collect chest pain data from patients, and they do fairly well. As noted earlier, the contract for revision of the chest pain program to include the ECG data is about to be let. As a first step toward developing the psychiatric system, the ability of corpsmen to make appropriate observations of severe mental disorders was evaluated. Selections from a film developed at a large southern university to train psychiatrists were presented to a group of corpsmen and a group of specialists in the field. There was substantial agreement between the corpsmen and experts as to what behaviors, attitudes, etc. the patients displayed. By the end of this fiscal year the psychiatry programs under development should be ready for evaluation in various settings with corpsmen as program users.

In summary, we have a microcomputer-based system that has been developed for use in isolated environments where the medical department consists usually of a single corpsmen who may be trained to work independently. Our goal is to

provide consultation to the corpsmen in a way that will improve his ability to treat his patient and make the important choice between a recommendation to evacuate the patient or to manage the illness on board.

Finally, what of the FMF? If the differences between the FMF and the Submarine Force are kept in mind, there is every reason to believe that the computer-based systems developed for one can be adapted to the other. Beyond that, computer applications to medical practice in all Naval and Marine units must be carefully coordinated if any are to prosper.

Hardware and Data Capture Devices

The Technology of Advanced Portable Information Products

William Flies, Chairman

Datakey, Inc.

Burnsville, Minnesota

A new industry emerged in the late 1970s that is called Advanced Portable Information Products. Its charter is to design, develop, and produce information storage devices that can be carried conveniently by people for the purpose of rapid and accurate information storage, information retrieval, and information recession. The underlying principle assumes that each has their own unique "transaction world" that consists of many different types of equipments that will access previously stored data, store new data, and revise existing data. These transaction points will each be a unique application such as medical, security, personnel, financial, process control, and others. The personalized products that respond to these requirements must be portable, durable, user friendly, and must support data access, storage, and revision for the multiple applications in a personalized transaction world.

In 1971, an innovative device called the microprocessor was invented. This microminiature electronic computer had significant data processing capability in an economical and easily integrated package. The world entered the "microprocessor revolution" and data processing capability suddenly became a common part of many products. Information processing was distributed to nearly every facet of our lives.

The microprocessor revolution was accompanied by an even greater appetite for information. The distributed processors were very capable of digesting and creating large quantities of information. However, the conventional portable information devices were incapable of providing the needed capabilities of data interchange and the desired capacities in a convenient and desirable people-portable format. Conventional ID's and cards, magnetic stripe cards, paper tape, punched badges and cards, floppy disks, printouts, written codes, and memorized data fell far short in one or more of the necessary capabilities. Advanced devices to match the processing capabilities were required.

First, the objectives of the Distributed Database had to be defined.

1. Portable -

   Conveniently carried by people in their everyday activities. Pockets, neck chains, key chains, wallets, shoes, etc. are the "normal" sites in which the devices will reside.

2. User Friendly or Human Engineered -

   It should be a device that people will carry and can use without any users' manual or training. There should be no "upside down" or backwards.

3. Fast Random Access -

   Data within the device must be accessible at subsecond speeds. Further, any piece of data must be accessible without the need to access unwanted data.

4. Retrieve/Update without Movement -

   Once inserted, the device should allow the equipment to retrieve desired data and revise desired data without any peripheral movement of the device. Movement to various data fields should be electronic. This differs from magnetic medias where the read/write devices and/or the media device must be physically moved to read and, again, to write data.

5. Application Independent -

   The device must not support only single applications. A person's transaction world will contain medical transactions, security transactions, financial transactions, etc. For example, if a device was built only for financial transactions, it could not be efficiently used for medical applications. New applications would not take advantage of the production economies from other applications.

6. Multiple and Concurrent Applications -

   People do not wish to carry a pocket full of devices - one for each application. The preference is to carry one device that will contain unique "information files" for their unique transaction applications. They need only to insert the device at the point of transaction and the equipments at that point will utilize the respective data to effect the transaction.

7. Application Flexibility -

   The device cannot dictate the information contents or information structure. That must be under the control of the application. The Data Content, Data

Organization, Data Alteration methods, and Data Security must be defined and applied by the application through its unique transaction equipments.

8. Simplicity of Interface Language -

The application must have a simple data-assisted "language" with which to manage its application and its distributed data devices. It should not be concerned about the physical structure or information structure of the portable device - only the convenient management of its data.

9. Reliability and Durability -

The device must be durable and reliable to withstand the harsh people-portable environment. That means a barrier to the effects of heat, moisture, corrosive environment, the extraneous fields of magnetic and static discharge, and excessive physical impact. Data retention must be maintained in all uses for periods in excess of 10 years without use and for a "life time" of frequent use.

10. Economical -

The device must be economically priced and still provide the necessary capabilities with advanced technologies.

Given the objectives of the Portable Database as defined above, a system or an approach had to be developed to support those objectives. Datakey has developed its patented approach to the total Advanced Portable Information Solution. It consists of three elements.

First, the Portable Element - the device that people carry - is the Database. It is a distributed and personalized Data Base unique to the person and distributed to the person on both a physical and logical basis. It is not a data processor; it is the database.

Our first portable information device or portable element was the Data Key. It is the shape and general size of a conventional metal key. This shape is already carried by people. People already know how to use the key shape. Although its shape suggests severity, it is a multi application distributed database that is shaped like a key because that shape is "user friendly."

Internally, the Data Key consists of a semiconductor memory mounted on a special membrane. The membrane and silicon memory are encapsulated into a

strong thermoplastic body for protection, portable convenience, and operational concurrence with access equipments.

The notable features of the Data Key include:

Semiconductor Memory

o This large-scale integrated (LSI) silicon memory is alterable - any word may be revised or altered.

o It is nonvolatile - it does not lose its contents when the power is removed.

o The combination of word alterability and nonvolatility is a relatively recent semiconductor capability. Most of today's nonvolatile memory devices can be written only once. Most of today's alterable memory devices will not retain information when power is removed.

o The capacity of the Data Key is 1400 bits.

o User Friendly - easily carried and needs no training to use -- simply insert and turn.

o Durability - exceeds the specifications for durability in the people portable environment

o Convenient

o Portable

Our second portable information device was the low capacity Data Tag. It is of the same basic shape as the Soldier ID Tag or "Dog Tag."

Internally, its construction is of the same technology as the Data Key except for the larger membrane. Like the Data Key, it has side-to-side redundancy. This means that the devices may be inserted with either flat surface facing up. There is no "wrong way" to insert the Data Tag or Data Key.

The features of the low capacity Data Tag are identical to that of the Data Key except the Tag has two large flat surfaces for visual information.

Our most advanced portable information device is the high capacity Data Tag family of devices. Again, it is shaped like the Dog Tag and has side-located redundant controls.

Internally, however, the high capacity Data Tag is much more advanced. Its membrane contains an alterable nonvolatile memory with bit capacities of 16,000 to 64,000. Further, it contains its own microcomputer; it is a "smart tag."

The computer provides much faster data management of the larger capacity memories while still communicating via only eight redundant contacts.

Its features are common to the lower capacity devices with the exception of the microcomputer and its capabilities.

The Portable Element is the database and takes different forms. Regardless of form, however, its objectives and general capabilities are constant.

The second element in the system is the Access Element which is the element that interfaces to the portable element and manages the data within the portable element. It consists of a device into which the portable device is inserted and a small microprocessor-based electronics interface module. The interface module:

- o Administrates the random arrival and departure of portable devices.
- o Communicates to the host equipment.
- o Manages data within the portable device via a simple command language administered by the host application.

It contains its own internal Data Base Management Software. The same module is used for both the Data Key and low capacity Data Tag. Only the access device into which the portable is inserted is unique to the portable device. In fact, the electronics module will concurrently support both a Data Key and Data Tag.

A higher level interface peripheral with industry standard RS232 communications supports "add-on" applications. This peripheral is shown in support of the high capacity Data Tag.

The final element in the system is the User System or equipment which is the Application. The general purpose portable elements and access elements are made specific by the way the User System applies them in the total application. The User System uses a simple data management language to access its data and to manage its data. Any given portable device may have other applications files for other applications, but the interface module interacts with the User System to make the portable device "temporarily unique" to its specific host equipment. A given user may have many different applications using common or private data files in the same portable device. For example, a field-belt worn device could

use a common file and create a new file of information. The battalion level could use different equipment to use those files of data and create additional data. Similarly, the Company and Fleet levels can utilize their unique equipments to manage common and private files as their specific applications dictate.

Let's briefly look at a few applications of advanced portable information to better understand the products' capability and flexibility.

First, a medical application of Computer Dialysis Corporation - a manufacturer of total kidney dialysis systems.

Initially, the Doctor prepares a Data Key that contains the patient's identification and specific dialysis parameters.

The patient goes to the comfort of the home or to a clinic for the dialysis process. The Key sets the machine specifically for the patient, as directed by the Doctor. During the process, "snapshots" of the blood cleaning process are stored into the Key for future review by the Doctor. The Key is both a data source and a data collector.

The artificial kidney or dialyzer also has its unique Key. This Key contains specifics on the type of Dialyzer, the assigned patient, and also records data during each dialysis process.

After each use, the dialyzer is "cleaned" by a special machine that uses data in the Key to perform this process most effectively. It also detects when the dialyzer effectiveness begins to diminish - a factor unique to each patient - so the dialyzer may be discarded. If still effective, the Key assures that it returns to the proper patient before a dialysis can be initiated.

In summary the Keys are effectively assisting in personalized medical process control and patient use security.

Other applications include personal databases such as the U.S. Army Soldier Data Tag that stores personnel, medical, and financial data. In this second application, these Data Tags are currently managed by U.S. Army programmed man-portable computers. Note the High Capacity Data Tag Reader on the left and the Low Capacity Tag Reader in the right side of the computer (slide). The Data Key reader is located above the tag reader and supports access security to the computer.

A third vending application demonstrates the Data Key's support of electronic funds applications. The Key is debited relative to the vend selection, and is "refilled" via currency conversion or on-line payroll deduction.

Automated Fleet Refunding Systems also use the Data Key for authorization, materials control, and vehicle maintenance records.

Industrial process control benefits from the "Shop floor durability" of the Key and the capability of selective alteration and "feedback" process improvement.

This concludes my presentation on Advanced Portable Information Systems. I hope that your knowledge of the technology, the capability, the flexibility, the portability, and the application of these systems has been increased.

Draft U.S. Army Unit and Division Level Medical ADP Hardware Requirements

Major Gary N. Lacher
U.S. Army Soldier Support Center
Fort Benjamin Harrison, Indiana

The Army's Air Land Battle doctrine for the '80s and beyond stresses the need to gain and maintain the initiative on a highly fluid and nonlinear battlefield. This must be done at great depth and across broad fronts wherever opportunities for offensive action are identified. This presents a difficult challenge to the medical unit commander. Military medical doctrine to address that challenge is rapidly evolving from concepts that make maximum use of modern electronic technology to address critical deficiencies. The Army's Medical Mission Area Analysis (MAA) has recognized the need for improvement in, among others, the following specific areas of medical operations:

1. The current field medical records system on the integrated battlefield is inadequate. Corrective action has been recommended through the development of a nondegradable, nontime-consuming dependably transmissible and transferable recording system.

2. Medical command, control, and communication are inadequate to coordinate essential medical units' activities at all levels on the integrated electronic warfare battlefield. Corrective action centers on the use of automated systems to speed data access and improve efficiency as it is used.

The Soldier Data Tag (SDT) project has been the most successful attempt to date to resolve the first deficiency, and as its associated hardware has been refined, a practical solution to the second has been demonstrated.

The most capable version of the SDT contains in its 64K bit EEPROM microchip the capacity to store a comprehensive medical record for use in initial evaluation at or near the site of wounding, with ample capacity for maintenance of a chronological record of treatment as the casualty is evacuated through the echelons of care. The vehicle for this capability has been dubbed the Hand-held Information Processor (HIP). Specifications for two versions are being sug-

gested and will be formalized in a procurement "market survey" to be conducted in the Spring of 1984.

HIP (MODEL I) FUNCTIONAL DESCRIPTION

Conceptually, the HIP I will be placed in all medical evacuation vehicles within the division area for the purpose of reading the SDT record and writing to it as required, to record treatment. It is approximately the size of a notebook computer, easily portable, and operates on batteries as well as common AC/DC power sources.

DISPLAY: Not less than 5 lines of 25 characters each. It may have a smaller display if it allows for the record to "scroll" at a rate of 150 baud and incorporates a display pause feature. Provisions for readability in darkness are required.

DATA ENTRY: It must have the ability to record information on the appropriate portion of the SDT medical record by means of bar-code input and by manual entry (keyboard) if the code reader is disabled either intentionally or through damage. All entries made to a SDT will be automatically stamped with date and time by an internal clock calendar.

CAPACITY: It has internal nonvolatile memory or replaceable magnetic media which allows the storage of at least 200 record entries of data on treatment provided and supplies used in treatment. These data will be down-loadable for later access and use by logistical and operations planners.

HIP (MODEL II) FUNCTIONAL DESCRIPTION

The HIP II will be placed in each Battalion Aid Station and in each Brigade Clearing Station. It contains the same features as the HIP I with the following additional features.

COMMUNICATIONS: It can communicate over standard AM/FM radio and wire to transmit and receive free text messages as well as preformatted/preaddressed messages for medical reporting and command and control. Security through ECCM is required and has been demonstrated.

DISPLAY: It has the ability to receive and display graphics based instructions in conjunction with the Position Location and Reporting System (PLRS) for command and control purposes.

CAPACITY: It has the ability to store in internal memory for instant access not less than 40 medical records down-loaded from patient SDTs.

SUMMARY

As applied within the medical combat support system, the SDT/HIP is designed to address identified deficiencies in our ability to provide support in the Air Land Battle environment. It makes maximum use of available technology for the improvement of support quality and the effective use of resources in a high intensity scenario. Its interface with the Army's Personnel Accounting System through automated casualty reporting is vital to the combat commander. Strength accounting data thus are more accurate and readily available as replacement operations are executed. It has utility in low intensity environments as well, including peacetime garrison operations.

Hardware and Data Capture Devices

Franklin R. Borkat, Ph.D.

Naval Ocean Systems Center

San Diego, California

Two years ago, at the second Conference for which this could be considered the third in the series, the major topic of discussion was the identification of the types of information needed at the various defined levels of echelons of care. I think at the time it was known that the Marine Corps had a number of field-hardened portable computers and that these IBM computers were used for personnel support, maintenance, and logistics. At that time, there were no plans for the computers to have anything to do with medical information systems.

Early care of casualties occurs in the same environment for which the IBM computer was designed, so it was an unstated assumption at that conference that computers and automated medical information systems might be available and used early in the handling of casualties. Casualty care and emergency medicine was the subject of one workshop.

There was considerable debate over where computers at any level might first appear. Some at the conference had Star Wars or Star Trek visions of pocket size calculator-like devices going out into the field with the corpsman to be used as he first encounters the casualty. This would be at Echelon I. Those with first-hand experience at that level described all the various circumstances possible at Echelon I--dirt, blood, darkness and hazard;--and it became quite apparent that with technology of two years ago and even today, the vision of effective and continued use of a pocket sized computer in combat exposure was probably not realistic. Computers at Echelon I were not considered appropriate. That the information might be entered into a computer at some later time, however, was deemed important enough to be considered at that level; so the decision on the basic elements of information started at Echelon I assumed computer entry at some point. These five critical elements were identification--which might also include blood type and allergies, wound type, narcotics administered, tourniquet applied, and time.

There has been a revolution in computer availability and use since the last conference. Where the field-hardened IBM portable computer, which weighs 260 pounds in its packaged-for-transport form, was the only microprocessor most people considered portable enough to be used even at Echelon II, there are now probably a dozen that would do an equal or better job. In fact, I would guess that within the last two years the majority of the people in this room either own or work with a computer that is more powerful, probably more portable, and a great deal cheaper than the one purchased for the Marine Corps. These are the so-called personal computers. There were at least four of these in use at the demonstrations yesterday. The model with the large capacity hard disk memory would serve well for medical information systems. The hardware technology shown by these computers makes very great the potential for getting a combat casualty information system early in the treatment process.

For the effective use of personal computers, all of us who work with them are aware of the one major skill needed to enter data into the computer for these devices to be useful for handling information. That skill is being a good typist and feeling comfortable in front of a keyboard. This skill is especially important for a medical information system where the consequences of incorrect keyboard entry can be serious. At the location where combat casualties are treated there will probably not be a clerk who has been trained in data processing and keyboard operations, and it will be the corpsman who enters the data. The data the corpsman enters must be accurate, and he will be under great pressure to enter it quickly so that the appropriate action can be taken and other casualties can be treated. The combination of speed and reliability coupled with the fact that corpsmen are not trained to be skilled typists make identifying other ways to enter data a desirable goal.

The casualty care workshop two years ago recognized the necessity for alternate means of data entry by requiring that, at the very minimum, the five elements of information needed at Echelon I be in a form that could be machine readable, thus eliminating typed entry. They also recognized the potential for failure of the computer system and stated the desire that the information also be human readable.

The remainder of this presentation is a brief description of the other means of data entry and what their potential is for providing machine-readable and human-readable information. I might add that the list may have been complete when it was organized last week, but like the rest of the computer-related field, it was probably outdated a few minutes after it was finished.

MACHINE-READABLE INFORMATION DIRECT TO COMPUTER

The most challenging problem for data capture is that of selecting a method of casualty identification that will work in the field environment. This mechanism must provide machine-readable information and be one that will survive battlefield conditions, contain enough information to be medically useful, and be worn by the Marine in the field. Three technologies offer potential solutions: 1) alterable semiconductor memory encapsulated in a protective carrier, 2) magnetic stripe on plastic, and 3) laser/optical memory cards. Although other-machine readable coding methods are in widespread use, including bar code and optical character recognition (OCR), these forms do not have enough information density for identification, which should include blood type and allergies. However, they may find use for the machine-readable form of administered narcotics, tourniquet applied, and time. I will discuss these other machine-readable coding methods, but in less detail.

Alterable Semiconductor Memory

The technology for reading and writing information on alterable semiconductor memory is a mature technology. Encapsulation of the memory into something that can be carried by a person, however, is relatively recent. In this technique erasable, programmable, read-only memories are covered with plastic so the semiconductor is protected, but the electronic contacts are exposed. Reading is performed by connecting the carrier to an electronic reader. Capacities for these memory devices are quite large. Current sizes are 2,000 bits (about 250 characters) for one such device to about 64,000 bits (64K is about 8,000 characters) for another.

Two projects are evaluating semiconductor memory for holding medical information. One is part of the Realtime Automated Patient Identification System (RAPIDS) project and tests a 64K semiconductor memory placed on a plastic credit

card size holder. The holder also contains a microprocessor chip so that the combined memory and computer can be very flexible in manipulating data. This card was tested at Ft. Lee, VA. For the test, only DEERS information was encoded on the card. DEERS is the acronym for Defense Enrollment Eligibility Reporting System. This project attempts to standardize a uniformed services information card so that with an automated medical registration system, a check can quickly be made on the eligibility of a patient whenever he or she tries to use a military medical treatment facility. Although space is available for some additional health care information, use of the card for this purpose was not tested. According to the contractor for this part of the RAPIDS project, the results were not promising. There have been some reliability problems with contacts and some of the chips fell off cards. Furthermore, these cards are expensive and were only available from foreign sources.

The other Army project has considerable promise for both a field medical identification and information card. This is the Army Soldier Data Tag project under development at Ft. Benjamin Harrison, IN. The semiconductor memory is encased in a durable plastic that physically resembles the conventional dog tag. Electronic contacts are protected and available at the edges of the tag. This device should withstand some of the rigors of use in the field. Due to its physical resemblance to the conventional dog tag, it should be acceptable by a combat soldier. The technology and potential of this technique will be discussed in detail by Mr. William Flies of DATAKEY, Inc, the manufacturers of the Soldier DIER Data Tag, and by Major Gary Lacher, who has performed the testing at Ft. Benjamin Harrison.

Magnetic Stripe

The magnetic stripe found on a bank card is a candidate for providing identification information on a casualty. The technology is as well developed as that of semiconductor memories, and there are numerous inexpensive sources for cards and readers that interface to computers. The conventional magnetic stripe card contains three tracks for recording information with a total capacity of about 200 characters. Track 2 is the most frequently used and is generally a read-only track with about 79 characters. The reading of infor-

mation from these types of cards is extremely reliable. Most reading techniques have associated error checking codes.

Magnetic stripe cards have been considered for patient identification at the National Naval Medical Center, Bethesda, since about 1978. Standard bank style cards were purchased and encoded for both inpatients and outpatients. Although suggestions were made for the information to be encoded on the cards, no standardization was provided for the cards, and no magnetic stripe reading capability was obtained.

One project related to magnetic stripes for patient identification is currently being pursued by the Department of Defense. The project is part of RAPIDS and uses DEERS, mentioned earlier, on a bank style card. Since most people are used to carrying bank type credit cards, an additional card with DEERS information would be quite acceptable. In such an application, direction would be provided by the Naval Military Personnel Command.

I had anticipated having a speaker here to participate from the RAPIDS program, but he was unable to attend. As I understand the project, it is an actual test of automated patient identification using the magnetic stripe card. At this time results should be available from tests at the medical activities in the Tidewater area of Virginia. Approximately 5,000 cards were used and tested at the Little Creek Amphibious Base, VA and aboard the USS SAGINAW (LST 1188). Of the three tracks available on the card, only one track for DEERS data was evaluated. Only eligibility information was contained on the card. No other medical information was considered, although the two other tracks could be used for information such as blood type and allergies. If magnetic stripe cards were used for combat casualty identification, DEERS information would already be present, and the addition of blood type and allergies would be easily possible.

There may be problems associated with this card when it is carried by a combat Marine in the field. Where the card is carried in a wallet or purse, exposure to mechanical deformation and environmental hazards are minimal. In the field the card will not be so well protected. The part of the RAPIDS test aboard the USS SAGINAW (LST 1188) may give some indication of card reliability with rough handling. The information standardized by DEERS and tested in the project will be useful for testing the value of machine-readable information in

a medical setting, but may not demonstrate the reliability of the bank card style carrier for field use.

Laser/Optical Memory Cards

In this new technology a laser is used to write onto a special optical recording material. The recording material can be encapsulated under a transparent protective layer of a credit card size carrier. The capacity of such a card would be over 16,000,000 bits of data (2,000,000 characters). Data could be added to the card but not altered. Among the advantages of the laser data card are that it does not wear out, and it is not susceptible to damage by magnetic fields as are both semiconductor memory and magnetic stripe. As yet, however, none of these devices is available for evaluation.

Bar Code

Bar code is the most used and most reliable of the short string forms of data entry methods. There are a number of schemes for bar coding in common use. Most have built-in error checking so that when the code is read, the error rate is less than 1 in 3 million. Reading with the wand does take a little skill, but it is easily learned. The Universal Product Code (UPC) found on most consumer items and used with the laser scanners in grocery checkouts is one of the bar code forms. UPC is a numeric only code, however, as are most of the other bar code types. Code 39, another almost standard code, does allow for alphanumerics of 36 upper case letters, numbers, and symbols, but it does require the most space at about 5 characters per inch. Thus, on a plastic card the size of a bank card, only about 15 characters and numbers could be encoded on any one line, and this would severely limit any field medical identification applications. Fifteen characters per card would allow the encoding of social security numbers for identification.

The bar code wand device is relatively small and is often designed for operating in areas where harsh treatment is common. Those devices designed to survive typical industrial operation conditions might also survive field use. Both fixed scanners and bar code wands can be obtained with interfaces for direct connection to most computers.

The bar code scheme of data capture has, in fact, been employed with the IBM computer used by the Marine Corps. Commercial bar code wands as well as portable, down-loadable units, all from the same manufacturer, were used at the 1982 Marine Corps Marathon to capture the finishing results. Both the wands and the down-load units were interfaced. Assembly language programming was used to read from the bar code units. The bar code scheme used for number reading only was the interleaved 2-of-5.

Use of bar code is becoming more attractive as a machine-readable form for entry of short data strings. In 1982 military standards were published identifying Code 39 as a way of marking all supplies and materials being provided to DoD and GSA when required. That includes medical supplies, which means that bar code technology could be used for material control. Also, the originators of Code 39 have given up any proprietary rights to the code and have participated in the establishment of voluntary health industry bar code standards. The draft for these standards is dated March 31, 1984. This means that we will see Code 39 bar codes on DoD and GSA materials and probably on all medical supplies as well.

It should be pointed out that none of the encoding schemes described so far is human readable. With the requirement for both machine-readable and human-readable code on an identification device that can be used in the field, none of the methods described is adequate. The military standard for bar code does, however, state that it must be accompanied by human-readable information.

Optical Character Recognition

Optical Character Recognition (OCR) is another form of encoding that is in widespread use. Initially, only a limited set of specially formed characters was used for OCR. With the advent of more powerful circuits and microprocessors for pattern recognition, most types of print can now be read. Again, as with bar code, OCR codes require considerable space. Common typewriter characters are 10 or 12 characters per inch, which would translate to about 30 characters on a line for a bank style card. The conventional type face for bank cards is larger than that of a typewriter, and only about 20 characters are actually used.

Wand readers are available for reading short strings of OCR print. Training for OCR wand use is also necessary, and OCR use is more sensitive to operator error than is use of the bar code. Also, OCR wands are more expensive than are bar code wands. Like bar codes, they could be used for reading casualty identification numbers and for assisting with inventory control. The major advantage of OCR is that it is both machine-and human-readable.

Two other kinds of readers are available for OCR, page and document readers. Page readers are useful for entering previously typed text into a computer system. If conventional typed medical records are to be entered on a large scale, an OCR machine, which has been reported to be able to keep up with 50 skilled typists, would be very useful. OCR readers, however, are very expensive.

Speech

Speech entry would be the ideal means of transferring information from a person to a computer because it would eliminate the considerable skills required for keyboard entry and even the minimal training for bar code or OCR wand use. Ideally, the vocabulary acceptable to the computer should match the words of the environment. At this moment, however, speech input as a data capture method is limited to a few controlled activities. Most systems are speaker dependent. Each user must train the system to his choice of words. Because of the size of the computing necessary for speech recognition, vocabularies of only about 200 words are in current use. Words when spoken must be separated in order to provide processing time for the computer, and this also contributes to the lack of widespread acceptance of speech as a means of data capture. Speech entry might also pose some additional problems in an area of high ambient noise--battlefield settings, for example.

It is difficult to keep current with advances in speech recognition as a means of data entry due to the tremendous research activity in this field. Major advances are announced almost daily, and I expect to see speech entry play a large role in all information systems, including medical, in the near future.

PORTABLE TERMINALS THAT INTERFACE TO THE COMPUTER

There is another class of device that might be considered for data capture. Although they are called terminals, they are basically portable, hand-held computers. These computers are battery powered, light weight devices that contain limited memory, a minimal keypad, usually a single line of display, and one operating program. They also often contain a time and date clock so that any reading event can have an associated time. The terminals and the program within are often designed to be the controller for one of the previously mentioned data capture devices (bar code wand reader, OCR wand, or magnetic stripe reader). Their main function is to read and store what is obtained through use of the data capture device. After some limited number of readings from the data capture device, the information is then down-loaded to a large stationary computer as a batch.

The portability of these devices is the critical feature. They can be moved to the source of the data, and this may be a necessity when obtaining information from a number of casualties. Rather than removing the machine-readable medical tag from a casualty, moving it to the computer for reading, and returning it, which could result in some mix-up, the tag could be read while still attached to the casualty using a portable terminal. Encoded medications and treatments could also be read. The original source of information need never be separated from the casualty.

These portable terminals could be used at the exit point from Echelon II. In this setting the data from the casualty or from the group of casualties could be read, accumulated, and forwarded via some communications link in preparation for arrival at Echelon III.

Some portable terminals are designed for operation in a dirty industrial environment and might withstand the same harsh environmental conditions of Echelon III as does the IBM computer used by the Marine Corps in the field. And, like the sealed unit in the demonstration yesterday, they could possibly survive the Battalion Aid Station setting of Echelon II.

SUMMARY

The Marine Corps has been using a transportable IBM computer to support personnel, supply, and maintenance management functions. Due to the ruggedization of the computer, it can be moved close to the forward areas of battle to provide more automated support for these activities than has been available previously. This also means that this computer could be used to support combat casualty information systems. There are now a number of other portable computers which might well serve medical needs. They should also be considered. To use these computers reliably and efficiently with the skills available to the medical community, every means of entering information into the computer should be examined. Identification of a casualty, injury type, and treatment are the kinds of information that can be handled by the data capture methods and devices described.

Combat Casualty Databases and Trauma Care

Surgical Study at Naval Support Activity Hospital, Danang, Vietnam[a]

James G. Garrick, M.D.

St. Francis Memorial Hospital

San Francisco, California

Introduction

Historically, military medicine has gained valuable clinical knowledge on the battlefield. As in past hostilities, there were unparalleled situations during the Vietnam War for study and documenting problems related to the care and management of the critically wounded in the field. The Naval Support Activity Hospital, a 700-bed, acute casualty hospital, located in the northernmost part of the Republic of South Vietnam near the city of Danang, was selected for such studies.

Methods

Information was gathered entirely at the NSA Station Hospital, Danang, RSVN, from the first of January 1968 to June 1968.

A team of six corpsmen was assigned to the project, to gather information on which this study is based. This was their only duty. Precoded sheets were used, and as each casualty was brought into the triage area it was determined whether they required primary definitive care and if an interview was possible. At times, information was gathered from the individuals who accompanied the casualties. Each patient in this study was followed on a daily basis by one of these six corpsmen. They followed the patient to the operating room, determined the amount of blood and fluids that were used, and followed them through their entire hospital course, and in some instances, through the evacuation system.

---

[a]Summary of presentation by Dr. James G. Garrick, compiled by Mr. Edward Gorham from the "Report of the Bureau of Medicine and Surgery Battle Casualty Meeting"; the study was performed by the Surgical Research Unit, Naval Support Activity Hospital, Danang, Republic of South Vietnam, Principal Investigators, Dr. James Garrick, and Dr. Larry Carey; Editor, Richard L. Bernstine, CAPT, MC, USN, January 30, 1973.

The corpsmen abstracted the operative notes. All the information was sent back and key punched onto IBM cards at the Naval Hospital, Bethesda.

In the majority of cases we were able to establish wounding agent by the history. If this was not possible, the Navy Explosive Ordnance Disposal Team would identify fragments and shrapnel removed from the casualty.

Results

During the period of the study, there were 2,600 casualties treated at the facility but only 2,021 of these were allied casualties. The remainder were either Vietnamese, Koreans, or POWs and were not included in the study for a variety of reasons. There were 59 deaths in the casualty group for a death rate of 2.92 percent. In the salvageable population we had 4 deaths. Seventeen individuals were declared nonsalvageable at the time of their admission to the hospital.

The wounding agent accounting for most casualties was artillery including mortars; gunshot wounds were second, some of which were multiple. Wounds due to booby traps were third.

Figure 1 illustrates the distinct relationship between type of wounding agent and duration of duty in RSVN. The curve describing the casualty load

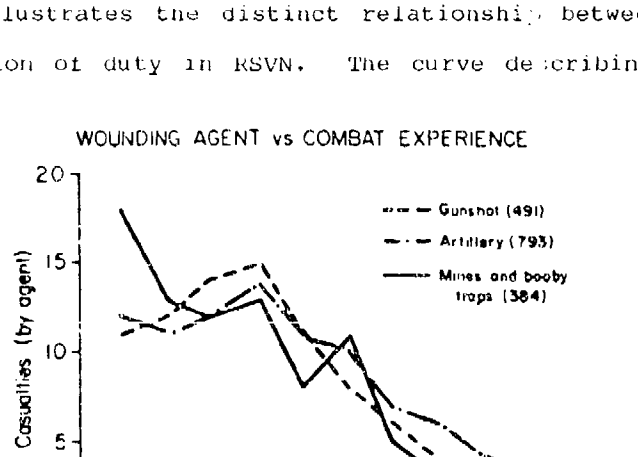


Figure 1 - Wounding Agent vs Combat Experience

caused by mines and booby traps shows a significant peak during the first month. These data seem to indicate the presence of a learning curve, insofar as being wounded by mines and booby traps is concerned.

Figure 2 related the evacuation time to the severity of the wound. Major wounds were those requiring one of the operating rooms. We found that there was little difference regarding severity of wounds and evacuation time. The variation in amounts of blood transfused according to wounding agent is shown in Figure 3.

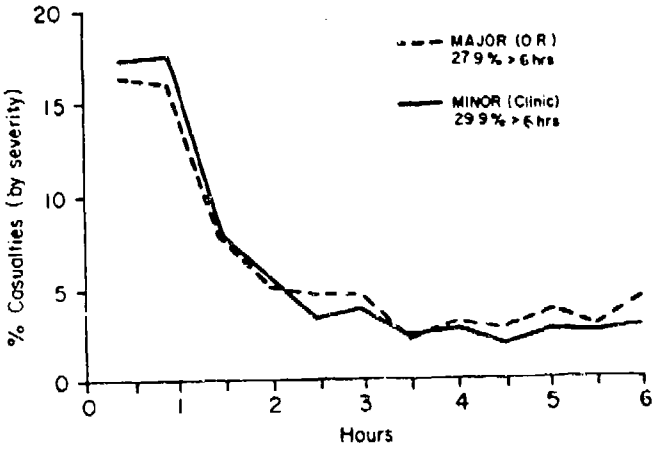


Figure 2 - Evacuation Time vs Severity of Wounds

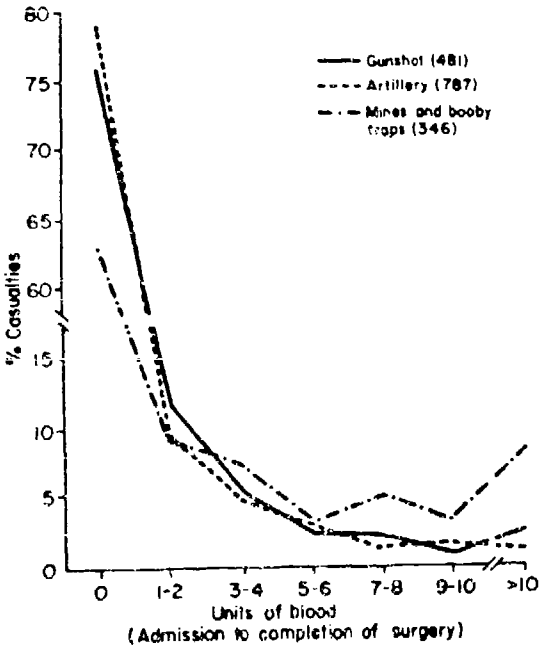


Figure 3 - Blood Requirements vs Wounding Agents

Mines and booby trap injuries generally required more blood. This is particularly evident when the total blood requirement exceeds seven or eight units. The blood requirements for casualties from artillery and gunshot injuries are similar.

Figure 4 demonstrates the relationship of wound site and hospital stay. Aside from extremity wounds which have a peak incidence at two days, the rate of discharge for various types of wounds is not changed during the study interval.

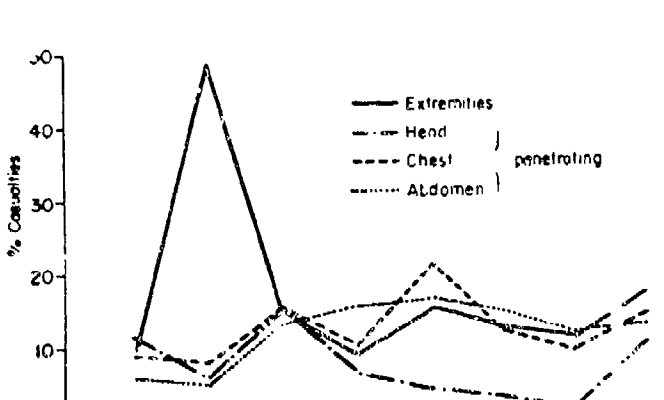


Figure 4 - Wound Site vs Time From Admission to Discharge

Consideration of location of the wound and its relationship to mortality is presented in Table I. The type of wound will indicate the specialists required for medical care and suggest manpower needs. Approximately ten percent of the casualties had head wounds requiring a neurosurgeon; eight percent had eye wounds which required an ophthalmologist.

Discussion

The ratio of wounded to killed from World War I, World War II, and, the Korean War is amazingly constant. The wounded/killed ratio for World War I, World War II, and Korea (average of all) is about three to one, but in Vietnam it was almost seven to one. I think this change is the result of helicopter evacuation of casualties. The improvement in the method of transportation allows casualties to arrive at the definitive care centers soon after they have been wounded.

Table 1

DEATH vs WOUNDS

Penetrating Head, Thorax, and Abdomen
458 (22.7%) of 2,021 Casualties

Site(s)	No. of Casualties	% of Total Casualties	No. of Dead	% of Category Dead
HEAD (Total)	199	9.8	36	18.1
Alone	178	8.8	27	15.2
THORAX (Total)	117	5.8	12	10.3
Alone	72	3.6	3	4.2
With Head	7	0.3	3	42.9
ABDOMEN (Total)	201	9.9	19	9.5
Alone	150	7.4	7	4.7
With Head	13	0.6	6	46.1
With Thorax	37	1.8	6	16.2
With Head and Thorax	1	0.1	0	-

N.B. Only seven deaths resulted from wounds not included in above categories.

In a breakdown of wounds, there is an almost identical number of wounds of the abdomen (which is a fairly large anatomical area) and wounds of the head (much smaller anatomical area). The same observation applies to wounds of the chest as compared to wounds of the head. This suggests that body armour was more effective at protecting the individual than were the helmets. There appears to be a substantial need for improvement in the mechanics of protecting individuals from head wounds. The importance of this fact is emphasized when one considers that of 59 total deaths in the study, 36 had only head wounds. If the patients with head injuries are removed from the mortality statistics, only 22 remain.

The lack of triage in the field was disturbing. It seemed, at times, that patients who had a minor wound were moved to the hospital with about the same frequency or time interval as patients who had major wounds.

It should be pointed out that this study would not have been possible were it not for a team of hospital corpsmen whose only responsibility was to collect data. This information was--for the most part--unavailable on medical records. Medical records in a combat situation such as this were very pragmatic, brief, working documents. Such information as detailed descriptions of wounds, transit times, and specific wounding agents were simply not recorded.

Past conflicts producing substantial numbers of American casualties have been spaced in such a manner that those medical personnel treating or studying the casualties have either left military service or have been elevated to positions with more administrative responsibilities by the time the next conflict occurs. Thus, the documentation of the management of battle casualties varies with each conflict, making comparisons difficult.

Efforts such as this conference should encourage a continuity of interest and involvement, making future investigations more expeditious and increasing the ease with which cross service cooperation could be employed.

The Role of the Battle Casualty Database in the Development of FMF Patient Care Information Management

Arden W. Forrey, Ph.D.
Harborview Medical Center
Seattle, Washington

As you have heard from Dr. Garrick, the origin of the Garrick-Carey dataset was the result of a desire to learn more about what care was actually being given in the field and specifically what kinds of injuries were seen at NSA, Danang. You have heard about the extreme effort which was required to extract a reasonably complete research database from clinical records that were kept there. This sample was representative of combat records in general up to that time. As most of you are aware, the completeness and organization of any emergency medical record is a major problem because of the setting. Missing data and fragmentation of the record are endemic components of most current emergency medical facilities, a fact that can be verified by the experience of the Seattle Medic One Organization.

Efforts to solve of this problem must be directed at both the registries which we use to collect data and to study patterns and methods of care and at the patient record which is used to manage the conduct of that care. If the data are present in the record in a well-organized fashion and reasonably complete, the research database will likewise be complete and accessible. What we have attempted to do so far is to restructure the Garrick-Carey data into a form that provides potential for long-term follow-up and enables looking at eventual outcomes. Translating the battle casualty data can help to build an FMF prototype patient care information system and a civilian trauma registry and to structure a new battle casualty record that reflects the structure of the original care record. The battle casualty record then contains elements that are clearly related to those which civilian trauma centers and professional groups are using to describe care in t' ir facilities. Obviously, this is just one cycle in the refinement process which will bring all of the important factors into a common trauma register. For good reasons the original data did not contain information about prehospital care--only how long it took to get to

NSA, Danang. We have identified the most useful data elements to be included and have structured them reasonably, using software tools that have generality, transportability, and commonality with another Federal health care agency--the Veterans Administration.

This commonality is important because not only do we want follow-up retrospective data on battle casualties in the Garrick-Carey dataset, but we want future compatibility with the V.A. system. Not only is the V.A. the follow-up agency for military personnel after active duty or full military careers, but, as all of you are surely aware, it is the immediate back-up agency for the military field medical system in the event of a combat contingency. So a great deal of thought and effort has gone into ensuring the "conceptual integrity" of the two systems. The software tools originated in the V.A., but they have been applied to the field patient care management problem first and then to the registries (civilian and military) which will be the repositories of elements from the patient care record. [The simplified logical structures of a proposed FMF patient record, the V.A. patient record, the Garrick-Carey Battle Casualty record, and the civilian trauma record depicting the parallel logical organizations, are shown in Tables 1-4.] Detailed documentation will be available in the working sessions.

There are a number of problems that this effort has highlighted. First and foremost is the urgency in agreeing on a general logical organization of the patient record. That is the vital question. If it is not solved, the situation will be analogous to a festering wound. I have long advocated getting to the heart of this matter using voluntary consensus panels sponsored at least by the participating Federal health care agencies. In the absence of such panels, we have gone ahead using the V.A. logical structure as a basic framework for the combat casualty record because it has the ability to host a unified ambulatory/inpatient data model that will not only accommodate the needs of combat casualty and general trauma care but be compatible with a record supporting fixed definitive care facilities. Other approaches exist and upon scrutiny are found to carry out the same general functions, but they do not provide the commonality needed in support of the continuum of care. The same logic, and indeed the same application software, cannot be applied to any level echelon facility in the continuum using these other approaches. Also, they are not directly related to

the battle casualty record. The question of the best logical structure for the patient record remains to be answered definitively and quickly by consensus.

If we get on track with a common patient record structure, then the issue which must be addressed is common lexicons, or dictionaries of terms, for the various data elements. TRIMIS has been wrestling with this problem and is aware of our needs. Professional consensus must be sought. One major example is to agree on the lexicon of terms needed to describe traumatic injury, both generally and specifically for use in a variety of settings and for numerous purposes. No single consistent set of terms exists to allow us simply, directly, and consistently to describe injuries in the detail needed for care management and at the same time use these terms for categorizing patients for analysis and research. The problem lies in the limited perspectives of the framers of current standard lexicons. Drs. Champion and Sacco have done battle with this issue, as have we, but more professional groups must be brought together and a consensus attained. The lack of a common, consistent but extensible lexicon of data elements was a major problem in designing the original battle casualty study, and Drs. Garrick and Carey made decisions as best they could. We are glad they did, or we would not have these data! We can and must do better from here on.

It is too soon to report on what the data will show, but Drs. Garrick and Carey did give us an overview in 1973. Further analyses will include an additional 5,000-6,000 medical records from the Inpatient Database at NHRC for about 1,500 of the database subjects. Dr. McCaughey will tell us more about this file. These cases will have a common context and will show how the attributes of these subsequent care episodes relate to those recorded by Drs. Garrick and Carey. An even greater challenge will occur when we try to include records from the V.A. Patient Treatment File to develop a picture of long-term outcome.

Another use of the patient records in the Garrick-Carey dataset will be to try to formulate case studies for different types of trauma and to develop a method for presenting these cases to student medical officers in terms of "loads of incoming wounded." This would allow students to learn clinical judgment processes for rank ordering priorities and readjusting these priorities when circumstances unexpectedly change. Again, we have Dr. Garrick to thank for

advocating these ideas. It is our intention to make inquiry into the database as convenient as possible for the surgeons who will be browsing through it to build such teaching scenarios. Moreover, we must begin thinking in terms of how to use the FMF casualty care information system management tools in this teaching process. In other words, we must learn how to do things that we would not have conceived of doing if we had only a stubby pencil! Thinking about this education process must begin now while we are still experimenting with the prototypes. Life Cycle Management documents tell us that we should be doing this, but we have to be more vigorous than the phlegmatic wording that emerges from such documents. After all, this is a medical tool that we are building to help all of us help our shipmates. If we do it well, when "push comes to shove" we will be able to cope. Our hope is that the new form of the database will give us help in the education of Hospital Corpsmen and all of the professional medical and dental specialties that will have a role in its use.

I have given you a brief overview of what the role of the Garrick-Carey database can be in acting as a forcing function in the development of a powerful new tool for health care in the FMF and eventually the joint services. The vision of Drs. Garrick and Carey has brought us this far, but I would like to call attention to the many individuals who have helped the project along, certainly not the least of whom is Dr. Ralph Kegua who nurtured the data tapes when they were on the verge of extinction and provided them to us as the phoenix risen from the ashes to aid in the evolution of an effective field information management tool for those now in the operating forces and those [illegible] to [illegible].

Table 1

Proposed FMF Patient Record

Name, identifying data

Demographic data

Military Status data

Residence data

.

.

.

Admission date-time (Multiple)

- Admission data
- Patient stay data
- Transfer/disposition data
- Patient classification data
- Patient status/prognosis data
- Injury time/description data
- Field and emergency medical treatment data
- IV data
- Vital signs data
- Medication data
- Lab and diagnostic data
- Orders
- Problem list
- Operative procedures
- Therapies
- Nursing care plans
- Nursing/progress notes

Table 4

V. A. Patient Record

Name, identifying data

Demographic data

Eligibility

Residence data

Beneficiary data

Medications

Physical Exams

.

.

.

Admission date-time (Multiple)

Admission data

Patient stay data

Transfer/disposition data

Table 3

Battle Casualty Record

Name, identifying data

Demographic data

Admission date-time

- Circumstances of injury data
- Admitting/disposition
- Injury description/prehospital care
- Resuscitative care
- Vital signs
- IV data
- Lab data
- Chest tubes
- Operative procedures
- Head and neck injury data
- Liver injury/treatment data
- Abdomen injury/treatment data
- Extremities injury/treatment data
- Extremities amputated
- Artery injury/treatment data
- Fractures/treatment data
- Joints injury/treatment data

Table 4

Trauma Registry Record

Name, identifying data

Demographic data

Admission date-time (Multiple)

- Circumstances of injury
- Admission to ER, hospital admitting
- Costs of care
- Patient condition at scene, injury, enroute care
- Prehospital care/transport
- Vital signs
- IV data
- ER injury assessment/treatment
- Lab/x-ray, diagnostic procedures
- Operative procedures
- Complications
- Outcome data

Databases for Analyses of Combat-Related Injuries, Diseases, and Disorders

CDR Brian G. McCaughey, MC, USN
Naval Health Research Center
San Diego, California

Three databases will be used to establish the incidence, management, and outcome of various combat-related diseases and disorders.

A database designed to study battle field casualties and their surgical management was established by Drs. Garrick and Carey at the 700-bed Naval Support Activity Hospital, Danang, Vietnam, in 1968. Data were collected between January and June 1968 on 2,600 casualties, 2,021 of which were allied. The database has extensive information about the events prior to admission at Danang as well as surgical management of the patient. Included are the following: months on duty in Vietnam terrain where the injury occurred, type of agent causing the wound, description of the injury, days on operation prior to the casualty, admission hematocrit, units of blood used at the end of the initial surgery, type of anesthesia used, and administrative disposition. Initial analysis of these data were completed in 1973, and the results were published in the "Report of the Bureau of Medicine and Surgery Battle Casualty Meeting," edited by CAPT Richard L. Bernstine, MC, USN, 1973.

It is planned that this report will be thoroughly reviewed, and further analyses will be conducted on unexplored areas of the database. Additionally information obtained from the Naval Health Research Center computerized medical and service history files will enable further analyses of individuals' health status after leaving Vietnam. In cases where this information is found, several factors will be studied, such as location, date, length of stay, and diagnoses at subsequent hospitalizations; medical and physical evaluation board actions; and date of and reason for separation from service. The possibility of obtaining additional follow-up data from the Veterans Administration will also be explored.

Another study will examine the incidence and course of battle injuries, psychiatric conditions, and other diseases and disorders during the Vietnam era.

This investigation covers all hospitalizations for Marine Corps personnel and selected categories of naval personnel (e.g., hospital corpsmen and construction specialties) during the period of 1965 to 1972. During this time there were approximately 691,854 hospital admissions of all types. Of the approximately 151,000 Marines in the database, 81,000 served in Vietnam. The 70,000 that did not serve in Vietnam will serve as a control group. Analyses will be conducted to determine incidence rates for battle injuries, nonbattle injuries, diseases, and mental disorders and to determine the relative risks among the various categories of personnel. This retrospective study will provide a basis for estimating casualty rates (battle- and nonbattle-related) under combat conditions, evaluating the relative importance of a number of risk factors and determining the consequences of disease or injury in terms of lost time or attrition and subsequent health and performance. The study also will contribute to improved casualty data collection and management.

The final database to be used in this series will be one that focuses specifically on psychiatric disorders. It will be generated from two sources: case consultations from Vietnam era psychiatrists and medical records from the Naval Health Research Center computerized inpatient database. The case consultations were recorded by psychiatrists who were stationed in Vietnam or on hospital ships off its coast. They will provide demographic information as well as reasons for the consultation, mental status, treatment, and disposition. The medical and service record information from the NHRC computerized files will provide an opportunity for long-term follow-up. Included will be such variables as time, location, length of stay, and diagnoses at the time of hospitalization; diagnoses at the time of medical or physical evaluation board actions; and date and cause of separation.

Simulating Medical Treatment and Evacuation of Combat Casualties with the NAMES Model[a]

Paul B. Richards

U.S. Naval Research Laboratory

Washington, D.C.

The model NAMES (Naval Amphibious Medical Evacuation Simulation) was developed to provide a computational tool for different medical treatment and evacuation systems which could be used in future amphibious operations. The model demonstrates the sensitivity of various evacuation systems to the available resources and follows the flow of each patient through the entire evacuation chain which consists of land-based and sea-based support facilities or combinations of both. It accepts any specified casualty admission rates and is designed to demonstrate the effect of the interdependencies among the elements of the system: (1) casualty receiving facilities, (2) vehicles used, (3) logistics, (4) medical technology, (5) command control and communications, and (6) tactical concepts and requirements. The model produces a considerable amount of output data and does not require historical data.

---

[a]This presentation was not planned for the FMF Conference but Dr. Richards was invited to discuss the NAMES model when its applicability to Marine Corps combat casualty care was recognized. This paper includes a major portion of the material presented by Dr. Richards at the FMF Conference. The paper was reprinted from the Proceedings of the NATO Conference on System Science in Health Care, Paris, July 1976, with minor revisions. The development of the NAMES model was supported in part by the U.S. Navy Bureau of Medicine and Surgery, the Naval Medical Research and Development Command, the Office of Naval Research, and the Office of the Assistant Secretary of Defense for Health and Environment. The use of the NAMES model for simulating and testing medical support concepts for the Fleet Marine Force is discussed further in the publication "Predicting the Effectiveness of Concepts for Future Marine Corps Medical Support Systems: Preliminary Report" by J. R. Fletcher and P. B. Richards, NRL Memorandum Report 4711, Naval Research Laboratory, Washington, D.C. 1981.

This paper describes the operation, the inputs, and the outputs of the model and presents a simulation of an evacuation system in detail. It also discusses the output variables obtained from several comparison simulations.

General Description of the NAMES Model

The NAMES model is capable of simulating various configurations of the basic amphibious medical treatment and evacuation chain illustrated in Figure 1. Casualty receiving facilities may be added or removed (completely, if desired) at any of the facility levels or echelons, and additional levels may also be inserted into the model. As each patient enters the system, he is classified according to the nature and severity of his wounds or illness, by assigning him to one of 75 patient classes. The 75 classes were defined by the U.S. Army Academy of Health Sciences and correspond to diagnostic codes defined in the U.S. Department of Defense Disease and Injury Codes. These patient classes encompass those wounded in action (WIA's) as well as diseased and non-battle injury (DNBI) patients and also include outpatients as well as inpatients.

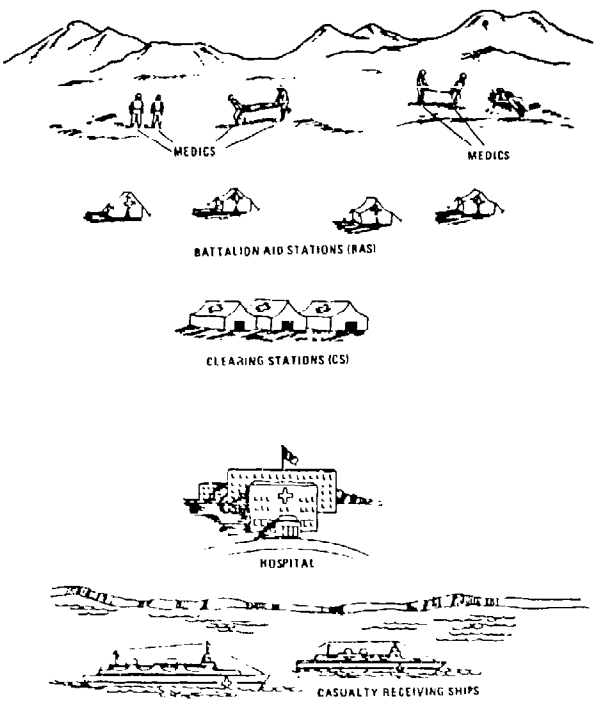


Figure 1. Basic chain of evacuation

In the NAMES model, each inpatient, or admission patient, enters the chain at the medic or corpsman level. Outpatients are allowed to enter at all levels. The class to which a patient is assigned determines, to a large extent, his flow through the evacuation chain and his processing at each facility that he enters. Each inpatient's class determines to which of three priorities he will be assigned: Priority 1, 'urgent,' indicates that the patient is in critical condition and must receive the most expeditious attention in order to save his life; Priority 2, 'immediate,' indicates that the patient's condition is very serious and he must be treated without delay; Priority 3, 'routine,' indicates that those patient is serious enough to require admission to the medical system, but requires no special attention to treat his condition. Outpatients are assigned Priority 4, which indicates that these patients may wait for treatment until there are no other patients at a higher priority requiring commitment medical personnel or (treater) resources. Each patient's class also indicates whether he occupies a litter or ambulatory status, and assigns to the patient an ordered sequence of medical treatments, called work units, which the patient must receive before he can convalesce and return to duty. For each patient, certain work units may be identified as critical work units in that any delay in completing them will cause death or prolonged convalescent time because of complications. Some patient classes, more serious than others, are assigned threshold times for initiating treatment at the medic level. If treatment is delayed beyond these specified times, the patient dies. These critical times associated with the various patient classes determine the mortality rate within the NAMES model and allow the user of the model to observe the resources and parameters of the evacuation system which affect the mortality rate. The NAMES model was intended to demonstrate the impact of new medical techniques and advanced medical training, in addition to technological improvements in transportation, health care facilities, logistics, and command control. Tests conducted with the model indicate that the mortality rate is quite sensitive to the selection of a patient's sequence of required work units and the allowable delay times for the patient to receive his critical work units.

At the medic level, all patients undergo triage and receive first aid on a first-in-first-out basis. Inpatients who survive this initial treatment are

then evacuated to the rear for further treatment; outpatients are returned to duty. At all facilities except at the medic level, patients are treated on a priority basis. After undergoing triage, each patient receives his sequence of work units, provided appropriate treaters are assigned. The NAMBS model allows flexibility in designating treaters by identifying preferred and alternate treaters for each work unit. An expected treatment time is associated with each treater's performance of a particular work unit. If an appropriate treater is not assigned to the facility level, the patient is stabilized and evacuated to the rear. Otherwise, the patient continues to receive his ordered sequence of work units. If he survives his critical mortality work unit, he is then stabilized for evacuation to the rear unless his prespecified convalescent time, following receipt of all of his work units, is less than the evacuation policy or holding policy which has been designated for his facility. This procedure is not followed at the hospital (or equivalently, a casualty receiving ship), which is considered to be the final facility level in the evacuation chain prior to evacuation from the combat zone. At the hospital, patients receive all of their required work units before being evacuated. At a battalion aid station and a clearing station, however, each patient's convalescent time, which is specified on his admission and may be extended if certain work units are not received in time, is constantly compared to the evacuation policy at his particular facility. If it should exceed the evacuation policy at any time, he is stabilized and evacuated to the rear, provided he has received his critical mortality work unit.

If a patient is able to receive all of his required work units, and if his convalescent time does not exceed the evacuation policy at his facility, he will enter a convalescent ward and return to duty from that facility if the convalescent bed capacity is sufficient. Otherwise, he will be stabilized and evacuated further to the rear. Two of the factors which cause a patient to be evacuated (treaters and bed capacity) are measures of the resources of the evacuation chain; the third (evacuation policy) is a command policy.

The order in which these factors enter a patient's processing within the NAMBS model is considered to be logical--if necessary treaters are not assigned, the patient must go elsewhere for treatment; once his critical work units are

received and he can be moved safely, he should be evacuated as soon as possible if it is known that he must be evacuated anyway; finally, if his facility has enough convalescent beds allocated, and if his convalescent time falls within the evacuation policy of the facility, he should be retained at this facility and returned to duty, and not evacuated further to the rear.

The NAMES model is 'driven' by various parameters, or inputs, which describe the resources and the operational environment of the medical evacuation system. These inputs consist of operational (tactical) inputs, such as the spacing of facilities, the number and arrival rate of casualties, and distribution of patients among patient classes; physical resources, including the numbers of casualty receiving facilities and evacuation vehicles, the numbers and types of medical personnel (treaters) assigned, the convalescent bed capacity, and the capacity and speed of evacuation vehicles; medical technology inputs, such as patient class descriptions, priorities, ambulatory or litter status, required work units, preferred and alternate treaters and treatment times, allowable delay times, convalescent times, stabilization times and evacuation threshold times; and command and control inputs, which include the evacuation policy for each facility, the patient entry facility following evacuation from the medic, and the number of nonurgent casualties that triggers a request for an evacuation vehicle.

The NAMES model computes and prints daily and cumulative statistics, at the end of each simulated day. These output data provide the model user with a quantitative method of observing various measures of the effectiveness of specific medical evacuation systems. This permits the relative comparison of different evacuation systems and also shows the sensitivity of an evacuation system to the various design parameters or inputs. The output data include measures of patient dispositions, such as the number who die, who return to duty, who are evacuated, and who remain at each facility, together with patient location at time of death--in treatment, treatment queue or evacuation queue at a facility, or in transit from one facility to another facility; lost time due to injuries and illness, including time spent in the system by those who are returned to duty, time spent in treatment and evacuation queues, the number of patients whose convalescent time is increased, convalescent time associated with

patients who enter convalescent beds or who are evacuated, and the number of patients evacuated from the operational area because their convalescent times exceed the evacuation policy, or because of the shortage of convalescent beds; resource utilization, including convalescent bed occupancy at each facility and the utilization of evacuation vehicles; and resource requirements, such as convalescent beds, stabilization beds, and evacuation vehicles.

NAMES Model Application

To illustrate the applicability of the NAMES model, six different medical evacuation systems were simulated using the model. In each simulation, all but one or two of the input parameters were held constant, in order to observe the effect of changing specific design parameters. The parameters that were varied included the evacuation policy, the number of surgical teams at the hospital, the number of convalescent beds at the hospital, and the number of ambulances located at the battalion aid stations. Two additional evacuation systems were simulated--one in which there were no clearing stations, and one in which all helicopters were replaced by ambulances.

The medical evacuation system simulation used as the baseline for comparative analysis was designed to support a Marine Corps combat division and used actual battle casualties recorded during the Chosin Reservoir Campaign in Korea in 1950. All six simulations used the same battle casualty data, which totalled over 5,600 admission patients during a 15-day combat period. In addition, approximately 150 outpatient casualties entered the system each day. In the base-line simulation, 360 medics supported the combat forces in the battle zone (see Figure 1). These medics were uniformly distributed along the FEBA; ten were assigned to each of 36 evacuation terminals, or landing zones. Each landing zone was linked to the hospital via an intermediate BAS and CS. There were nine BAS's, three CS's and one hospital; the hospital supported the three CS's, each CS supported three BAS's, and one each BAS supported four landing zones. The base-line simulation contained no casualty receiving ships. In the baseline simulation each CS had 60 convalescent beds, the hospital had 200, and none was allocated to the medic or BAS level; two surgical teams were assigned to each CS and also to the hospital, with none at the medic or BAS level; six

ambulances were assigned to the hospital, three to each CS, one to each BAS, and none at the medic level; 16 helicopters were assigned to the medevac pool; and finally, the evacuation policy in force at the hospital was 15 days, at each CS three days, and was zero days at the medic and BAS levels. These inputs were varied during the six comparisons simulations. Other inputs, which describe the patient classes, the work units, preferred and alternate treaters, and delay times, are described in detail in the NAMES model program documentation.

The three principal measures of patient dispositions--the number returned to duty (RTD), the number evacuated (EVAC), and the number who died throughout the 15-day combat period--are listed in Table 1 for the six comparison simulations. As one would expect, the mortality rate drops when the number of surgeons at the hospital increases (Simulation 2) and rises when the helicopters

Comparison simulations	RTD through day 15	RTD subsequent to day 15	RTD total	EVAC through day 15	Died through day 15
1. Base line	50.6%	3.4%	54.0%	41.4%	4.0%
2. Base line with 400 beds and 6 surgeons at hospital	56.8%	5.3%	62.1%	35.6%	1.8%
3. Simulation 2 with 45 day evacuation policy at hospital	51.2%	7.2%	58.4%	39.2%	1.8%
4. Base line with helicopters replaced by ambulances	51.1%	3.2%	54.3%	36.8%	8.4%
5. Base line with no clearing stations	44.3%	3.2%	47.5%	47.8%	4.1%
6. Base line with 3 ambulances at each battalion aid station	51.0%	3.1%	54.1%	41.8%	3.5%

Table 1. Patient dispositions, expressed as percentages of total number of casualties entering system through 15-day combat period

are replaced by slower ground ambulances (Simulation 4). Increasing the number of hospital beds (Simulation 2) increases the number returned to duty (RTD) and decreases the number evacuated from the system (EVAC), but this improvement over the base-line simulation (Simulation 1) diminishes when the hospital evacuation policy is lengthened (Simulation 3). The reason for this is that the hospital convalescent beds were fully occupied by the end of the second day of combat, so

that further admissions had to wait for vacancies to occur. The longer evacuation policy of simulation 3 reduced the rate at which vacancies occurred, thereby denying admission to more casualties, forcing them to be evacuated from the combat zone. Once they left the combat zone, they could not be returned to duty. Simulation 5 shows the importance of the convalescent beds at the clearing stations. When the 180 convalescent beds allocated to the three clearing stations were removed, casualties who would otherwise have returned to duty from the clearing stations were forced to go to the hospital. Since that facility was already filled to capacity, these casualties had to be evacuated from the combat zone.

Figure 2 shows how the NAMES model can be used to study the combined effect of the evacuation policy and convalescent bed capacity on the convalescent bed

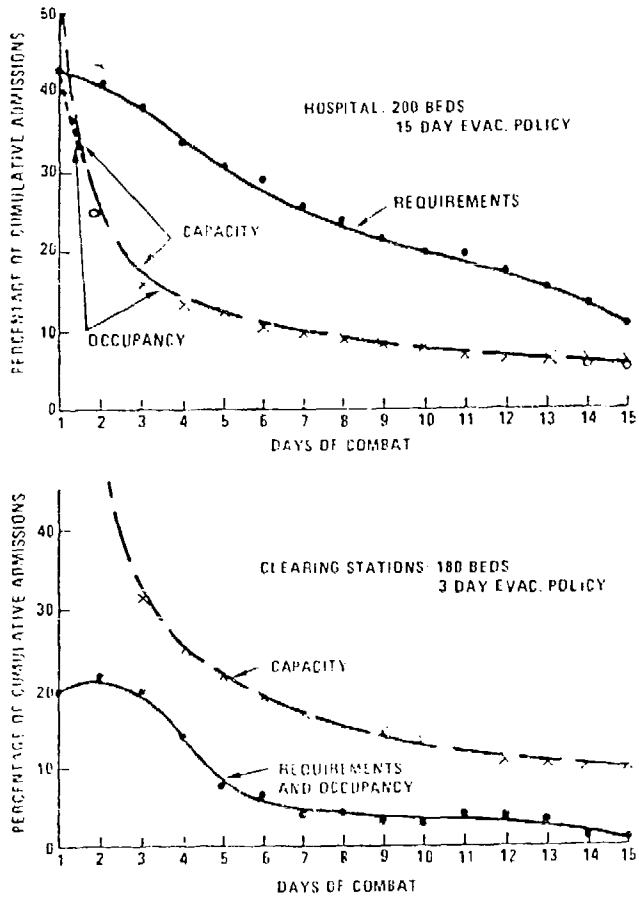


Figure 2. Baseline simulation of convalescent bed requirements, capacity and occupancy.

occupancy, which is a measure of the number of patients to be returned to duty. To determine convalescent bed requirements, the NAMES model records the number of patients who, upon receipt of all of their required work units, have convalescent times which do not exceed the evacuation policy at their facility. All of these patients will be allowed (by the evacuation policy) to recuperate at their facility and subsequently return to duty provided the bed capacity is sufficient. Consequently these patients establish the bed requirements at the facility. Clearly the convalescent bed occupancy cannot exceed either the convalescent bed capacity or the convalescent bed requirements. These last two factors are independent of each other. The upper curves of Figure 2 show that in the base-line simulation, the hospital convalescent bed requirements dictated by the 15-day evacuation policy overtake the 200 bed capacity prior to the second day of combat. The only way to increase the bed occupancy is to increase the bed capacity. Even if that cannot be done, however, a shorter evacuation policy would have the effect of returning more patients to duty, because it would result in a higher turnover rate in the convalescent ward. By contrast, the lower curves of Figure 2 show that the combined 180-bed capacity at the three clearing stations exceeds the requirements imposed by the 3-day evacuation policy. In this situation, a longer evacuation policy would make more efficient use of the bed capacity.

The present discussion demonstrates that the model is an effective (and inexpensive) device for planning and studying combat zone medical care systems together with the requirements those systems impose on supporting medical, transportation, and logistics facilities.

Dental Care for Combat Casualties

LCDR Mark C. Diehl, DC, USN

Naval Dental Research Institute

Great Lakes, Illinois

The principal role of dental service to the field force is to contribute toward enhanced operational readiness. The objective of this service is to prevent dental emergencies in the field and to effectively treat those which do occur so that the patient can be rapidly returned to duty in the field. Thus, the primary emphasis of dental service is the reduction of noncombat dental casualties. Efforts in the area are typically a garrison function and cannot be considered as combat casualty treatment or combat dentistry.

In the scenario under consideration, treatment of maxillo-facial wounds is the primary focus of combat dentistry. Information needs for effective management of the maxillo-facial casualty appear to be well met by the projected automated casualty medical record and its data structure. From the oral surgical viewpoint, there is a need to record dosages for all administered medications, especially local anesthetics. There is also the need to provide for epinephrine/vasoconstrictor-containing local anesthetics.

The combat casualty information system must perform well across the spectrum of potentially chaotic events. Casualty treatment experiences revealed in this conference indicate that simultaneous treatment of multiple casualties will be a common event. Removal of battle gear, clothing, and identity tags often accompanies treatment of these casualties. There is potential for confusion of casualty identity in such events. Currently, the most convenient physical link between the casualty and the electronic identity tag is by dental comparison.

Algorithms for matching dental attributes on both electronic records and oral examinations were developed several years ago at the Naval Dental Research Institute (1). More recently, similar approaches have been perfected by the Army Institute of Dental Research (2). An abbreviated dental record, containing current dental data sufficient for these automated matching algorithms, would require approximately 100 characters using binary data compression. This record

could be kept current through updating at garrison as dental treatment or identification of subsequent disease changes the dental status.

A proposed data layout for the dental field in the combat medical record is as follows:

1.	32 positions, each of 3 characters	(96 bytes)
	a. missing tooth	1 bit
	b. restored surfaces	5 bits
	c. restoration material	6 bits
	d. prosthetic replacement	2 bits
	e. diseased surfaces	5 bits
	f. disease cha. restoration material	6 bits
	d. prosthetic replacement	2 bits
	e. diseased surfaces	5 bits
	f. disease characteristics	5 bits
2.	current dental class	1 byte
3.	reserved space	3 bytes

A more detailed dental record, suitable for routine garrison use, would require an additional 2604 characters. Also, use of a variable length record with data-base operation would alter data content and volume.

References

1. Cohen, M.E., Schroeder, D.C. and J.C. Cecil, Computer-Assisted Forensic Identification of Military Personnel. Military Medicine, 148/2: 153-156, February 1983.

2. Lorton, L., Grover, P., Murray, D,. and W. Langley, Correlated Incidence of Restorations: The Use in Identification. IADR Abstract No. 1511. March, 1984.

Summaries of Technical Work Group Discussions

Session A: Prototype Software Systems

William M. Pugh

The work group began with a review of alternatives to the Field Medical Card by LCDR Michael Congleton. There was general agreement that the existing card is inadequate, but a variety of opinions were expressed about the best method for correcting the card's deficiencies. In addition, it was pointed out that there are NATO agreements which specify that certain data are to be contained on a medical card. It was indicated, however, that much of the data required by these agreements was not information needed for casualty treatment and, therefore, was one of the factors that limits the usefulness of the present card. It was noted that the Army apparently avoided this problem by not using a Field Medical Card at all. Instead, the first place the Army would record medical data on a casualty would be in the ambulance when the casualty was being evacuated rearward, and in the ambulance a digital command terminal would be available to record data electronically. However, the Marines state that they do not plan to use vehicles at the forward edge of the battle area in the same way that the Army is planning to do. As a result, it was felt that devices such as a command terminal may not be available and that the Marines should still plan to have some type of paper or hard-copy record of the initial treatment. Moreover, a hard-copy record provides a back-up system in the event of ADP failure or exposure to electro magnetic pulse. Because most of the discussion was concerned more with the mode of data collection than with the specific data that were to be collected, it was noted that the approach that had been taken, whereby the data needs for each echelon of care were identified first and development of the best method for capturing the required data was to be performed as a separate step, was very appropriate and should be continued. Finally, with respect to developing a new manual Field Medical Card, it was suggested that the problems resulting from attempts to accommodate the NATO agreements could be averted by changing the instructions that implement the agreements.

The second topic discussed concerned the automation of sick call functions in a field environment. It was pointed out that in the Marine Corps, sick call is conducted at the Battalion Aid Station (BAS), but according to the system

design that had been discussed, the microprocessor for managing medical information would be placed one echelon further back--at the Medical Company. Therefore, the primary processor would not be available for sick call management. At this point the opinion was expressed that sick call was of tactical importance and should be automated if possible. It was suggested that one of the hand-held devices might be used in this capacity.

The above discussion also served to highlight an inconsistency between Marine Corps doctrine and the proposed system design. According to Marine Corps doctrine, medical records are maintained at the BAS, and in the proposed system the medical information management would be conducted at the Medical Company. It was noted that it is technologically possible to produce duplicate files of electronically stored data and thus medical records could be maintained both at the BAS and the Medical Company. However, this concept was rejected because it was felt that such a system would result in multiple versions of the record for a single patient--some of which might be current and others out-of-date. To solve this problem, it was proposed that the field medical record be carried by each individual as part of the information on the electronic data tag. Then it would not matter whether the Marine was at the BAS or at the Medical Company--his medical record would be available.

If the data tag is used to hold the entire field medical record, then the storage of information on it must be carefully managed so that all the data available can be accommodated. Thus it was suggested that variable length records and modern database management techniques should be used if possible. Then storage space would be occupied only by positive findings. For example, space would not be reserved for a series of shots that were not given, but a list of unlimited length could be maintained on the shots that had been administered. The ensuing discussion dealt with the capabilities of the media being evaluated by the Army for the soldier data tag and whether that device could support advanced storage schemes. Those present who had used the media stated that there should be no problem with storing data in any fashion desired.

Discussion of different methods of data storage gave rise to questions regarding the compatibility among information systems. At this point a representative from NAVMASSO was asked to review the Shipboard Nontactical Auto-

mated Data Processing (SNAP) program so that the working group would have a specific example of another system with which a field medical system should interface. The SNAP review revealed that the overall program consists of two parallel efforts--SNAP-I for large ships and SNAP-II for the smaller ships in the Navy. The functions presently performed by these systems include administration, supply, financial, and maintenance. Some medical functions are performed by SNAP as part of the administrative module, but this is only a minimal effort and does not constitute a full medical recordkeeping system. However, the Mission Elements Need Statement (MENS) that has been approved for SNAP does contain the requirement to develop shipboard medical functions. To satisfy this requirement, specifications must be documented for the functions to be performed. Then those specifications must be given to SNAP personnel and the resource sponsor must be identified. Therefore, the capability for interfacing SNAP and the combat casualty system can be facilitated by developing functional specifications for SNAP that include the need to interface with combat casualty care.

With respect to developing interfaces between systems, it was noted that we must not lose sight of the fact that the first priority is to develop a field medical system and interfacing with external systems could be considered a Phase Two effort. In the meantime, interfacing could be accomplished the same way that it is presently done--by sending hard-copy reports from one place to another. Then, at a later time, electronic methods could be devised for passing messages. It was suggested that system compatibility could be promoted if some standards could be agreed upon. For example, standardized coding schemes already used by TRIMIS could be adopted for all other medical information systems. Or, a common language could be used. Members of the working group felt that standard coding conventions may be beneficial, but a common language was not critical for interfacing systems. Finally, it was suggested that if a system prototyping approach were adopted, then system compatibility would be assured. It was argued that prototyping might be preferred because prototyping has a history of producing workable systems in a timely fashion.

The Trauma Score that had been described during the paper sessions was discussed briefly. Participants generally felt that the Trauma Score had merit

although they did admit it could be abused. If the score was used to dictate actions and functioned as the decision maker, then that would be an abuse of the index. However, it was agreed that the Trauma Score could be a valuable tool in the field, especially for personnel with limited medical training or experience. Corpsmen could refer to the Trauma Score in the same manner they would use other medical indices and look to it for guidance when more experienced help was not available. Also, because the Trauma Score does provide a method for quantifying the severity of a casualty, it is considered to have utility for casualty management. Finally, it was noted that the Trauma Score represents only one of many functions that can be performed on the data that are gathered using a microprocessor in the field. Other functions that could be performed include computer-aided diagnosis, medical regulating, personnel accounting, supply/resupply, and epidemiology/teaching.

When the question of system security was raised, it was answered quickly. It was pointed out that any corpsman or physician who should have access to the system could have an access code entered onto his own data tag. Any authorized person could gain access to the system, then, by simply turning it on and inserting his own data tag into the reader.

The session concluded with the observation that no system can be deployed into the field unless the input required by the user in the field is repaid with output needed by the field user.

Session B: Hardware and Data Capture Devices

Franklin R. Borkat, Ph.D.

The technical work group was represented by those who initiate care of the combat casualty at Echelon I and know the problems that would be faced by any equipment for medical information in this least controlled environment. There were experts in the latest technology of computer devices who could assist in the description of the hardware capabilities. Finally, the Navy, Army, and Air Force were represented by at least one person knowledgeable in that particular service's medical information and hardware objectives. While all of these people had specific statements to make relative to their expertise, what was discussed and what is reported here represents opinion and not official policy.

The discussion first started by trying to identify at what level electronic or automated recordkeeping could be initiated. The harshness and the haste of the environment was the main consideration dictating where any sophisticated equipment could be placed. It was noted that due to different battle tactics, no single location would serve for all three services. The Army anticipates terminals working with the medical record at the level of the battalion aid station. They also plan to provide ambulances with comparable equipment. According to Marine Corps medical operations, major additions to the combat medical record as well as the environment would not allow successful use of computers until Echelon III.

Power and equipment failure were a major concerns. Wherever any system would be located, duplicate systems and power failure protection would be required as a back-up. This might mean duplication of hardware but not necessarily two parallel systems.

All three services participated in the debate on the appropriateness of something like the Soldier Data Tag for use as a portable medical record. The Air Force is just finishing tests on the Datakey as a portable electronic identification device in Korea, so they are concerned with the same problems. They are also looking at devices other than the Datakey. Of the devices known, the consensus was that semiconductors on a plastic card of the bank card style, like that tested in the RAPIDS project, was not durable enough. The laser card has a greater capacity than the largest Data Tag, but with the current technol-

ogy, it is not rewriteable. The laser card would be good for archiving historical records but not for a combat casualty record. It was agreed upon that the Soldier Data Tag provided the reliability and capacity necessary for a portable medical record for casualty care.

As a reiteration of reliability and capacity, we were told that the Data Tag could be encapsulated with a material which would survive in circumstances more severe than that in which the conventional dog tag would survive. As for capacity, encoded casualty data was projected to occupy less than 10% of the space of the tag currently under test by the Army.

Because of the potential of the tag as a portable database, it was stressed that its use for medical purposes was secondary. The major application would be for personnel data, and this presented some serious problems for standardization of such a device throughout the military. Because of different organizational and information needs, it would appear to be impossible that all the information on the tag would be the same. Rather than having three devices, it was suggested that the mechanical and electrical design and information format be standardized, but that the data be allowed to follow the requirements of each service. Communication of data from one service's Data Tag to another service's computer system would be by software translators in the computer. This is a somewhat confusing but important point. It means that an Army Soldier Data Tag, for instance, would fit and be electrically compatible with a Navy reader, but that the location of the information and the kinds of information on the Tag would not be the same as on a Navy Data Tag. This means that only a single reading device would be needed, but that each service can decide what is on the tag according to its needs.

It was suggested and not objected to by those present that there be some sort of joint service agreement on the mechanical, electrical, and information format of a device like the Soldier Data Tag. This decision should be made in the near future by some jointly represented committee.

The work by the Army at Fort Benjamin Harrison is the most advanced to date, and the feeling was that it would be reasonable to use that experience in any combat casualty information system for the FMF.

Security of the information was discussed briefly. With a Data Tag having some computer power within it, a "smart card," security systems could be built into the reading of the data. Security then becomes a problem of program or software design with access levels and information controlled or erased by codes from outside.

If any hardware, either card or computer, is to be used by combat personnel, it should first be tested in a hospital to identify any potential problems. It should also be continuously used so that it is not a new experience when first encountered by a corpsman in the field. If such a device is too expensive when made for field use, it could perhaps be an item that is used while on active duty, returned, and then issued again, or there might be different versions, depending on the anticipated exposure, with a full military specification device for field use.

The corpsmen present stressed that if any system for automated recording were to be successful, and if it were to be used at Echelon III or earlier, it should not rely on keyboard data entry. Other forms of data entry were discussed, voice entry being of particular interest. A suggestion was made that to overcome the problems of training the voice recognition equipment to a particular corpsman, he could carry a different Data Tag which would not only allow him access to the computer, but also carry coding necessary to use his voice for data entry.

Bar code reading was deemed acceptable for short data strings as a reliable and rapid input scheme even under adverse conditions.

Input of the timing of an event was noted as important to the care of the casualty, but no solution was proposed that would work at the level of Echelon I, other than training the corpsman to write down the time.

Session C: Combat Casualty Databases and Trauma Care

Frank C. Garland, Ph.D.

The Combat Casualty Care and Databases Work Group had as its objective the determination of the information needed to provide the best possible medical care for combat casualties in the Fleet Marine Force (FMF).

Some issues unresolved at previous conferences on this topic were discussed in depth. Specific data items to be collected at each echelon level were reviewed at this session, and recommendations were made. The following are some observations and the recommendations of the Work Group.

I. General Observations

A. Future combat scenarios are expected to differ from Vietnam with respect to air support for medical evacuation. Routine evacuation time for casualties may increase to four to six hours because of greater use of highly mobile forces with less air support.

B. The Vietnam experience showed the high efficacy of battle casualty management at the hospital level; therefore, improvements in combat casualty survival are dependent on prehospital casualty management procedures.

C. There is a lack of information on casualties that do not survive to Echelons III and IV.

D. Evacuation decisions are as often tactical in nature as they are medical, and there is a lack of information on evacuation decisions prior to Echelons III and IV.

E. Only data important in clinical management are likely to be collected by corpsmen in the field.

II. Recommendations

A. Echelon I

1. An alternative to the present Field Medical Card (Form DD 1380), which is unduly complicated and impractical for field use, is needed as was determined at previous conferences.

2. An objective measure of injury severity is needed to assist the

hospital corpsman in decision making at Echelon I. The components of this measure have not been determined. They may include The Washington Hospital Center Trauma Score, an abbreviated trauma score, vital signs, or these assessments in conjunction with other information such as blood loss and nature of injury.

3. A prototype objective injury severity index should be decided upon and tested to determine the utility of this measure in medical decision-making by the hospital corpsman at the earliest time possible, and this testing should be carried out by specially trained and designated corpsmen.

B. Echelon II

1. Type of injury

   a. Combine dislocation and fracture categories.

   b. Combine 1^{o}, 2^{o}, and 3^{o} burns in one estimate of percent of body area affected.

2. Procedures/treatment

   a. Times of application of tourniquets should be recorded (Date/Hours/Mins).

   b. Utility of recording presence of splints and bandages was questioned.

   c. Categories of tubes should be expanded. More definition of chest and endotracheal tubes needed.

   d. Utility of recording Casting/Immobilization of body part and method was questioned.

3. Intravenous solution

   a. Volume, time, and type of fluids should be recorded each time administered.

   b. Intravenous additives should be recorded.

   c. D5W solution category, gauge of needle, and location to be deleted.

4. Medications

   a. The category of "other" should be added under each medication grouping.

b. Sulfa category should be deleted and "other" substituted.

C. Echelon III

1. Injuries

a. Type and anatomical location of injuries should be further expanded, including further characterization of burns.

2. Procedures/treatments

a. Volume, time, and type of solutions should be recorded each time administered.

b. Intravenous additives should be included.

c. A complete input/output record for fluids should be developed.

3. Laboratory tests

a. Blood culture category should be added

4. Anesthetic type

a. Category of "ether" to be deleted.

b. Categories of anesthetic agents to be expanded.

c. Categories of administration routes of anethesia to be expanded.

Conference Summary and Recommendations

Dr. Gunderson: In this final session I would like to review what we have accomplished and ask for your comments and suggestions concerning future efforts.

The Conference began with demonstrations of prototype software for a casualty care information system and hardware and data input devices that might be suitable for use in combat settings. These devices included hand-held terminals, bar code readers, and electronic data tags--an impressive display of state-of-the-art equipment. These technological advances appear promising with regard to achieving some degree of automation at forward echelons of care. In particular, the Army's testing of the Soldier Data Tag could provide at least a partial solution to the difficult problem of rapid automated data entry and storage under highly mobile field conditions.

The software components that were demonstrated performed a number of basic functions involved in processing casualty information: identifying and tracking individuals through various environments and organizations; collecting, storing, and displaying the data elements in the combat medical record; computing and using Trauma Scores in a field setting; and using patient signs and symptoms to make computer-assisted diagnoses. These special software capabilities may eventually expedite triage and acute trauma care in the field, but much more testing and evaluation needs to be done. Such aids cannot replace clinical training and experience but may facilitate recordkeeping and decisionmaking.

Videotape and film presentations were informative and provided some measure of realism for Conference participants. The videotape prepared by the Training Department, Camp Pendleton Hospital, illustrated current Marine Corps casualty treatment and evacuation procedures in the field. Dr. Hirsch's film, a case study of a severely wounded Marine, showed initial emergency surgery at the Naval Support Activity Hospital, Danang, Vietnam, and follow up through long-term rehabilitation. The film vividly depicted the realities of acute trauma care under combat conditions and provided a visual record of a remarkable recovery from grievous wounds in battle.

The Introductory Session (Session I) presented the history and objectives of the FMF project and laid out the goals and organization of the Conference. The progress made at previous combat casualty conferences was summarized. It was noted that the results of previous conferences had been incorporated into revision of the existing Field Medical Card and design of a new combat medical record.

The technical presentations and work group discussions in Sessions II and III were organized around three topical areas that reflected the principal objectives of the meeting: design prototype software for a casualty care information system, evaluate hardware and data capture devices for field use, and survey trauma care processes and available combat casualty databases. The extensive discussions on these topics as well as some unresolved issues from previous conferences were summarized in the Chairmen's reports of the deliberations of the Work Groups. Many of the key issues pertaining to design and implementation of automated combat casualty medical records were thoroughly explored in these discussions which provided valuable guidance for future development efforts.

Comments and Recommendations

In the final session the Chairman solicited comments and suggestions from a number of Conference participants. The recommendations made included the following: (1) organize a future conference to review progress and exchange new ideas and approaches, (2) establish a close liaison between the Army TAMMIS project and the Navy combat casualty information system project, and (3) form an expert panel on military trauma care to guide simulation studies of combat triage/treatment/evacuation scenarios using the NAMES model described by Dr. Richards. These recommendations will be incorporated into ongoing system development efforts as time and resources permit.

Concluding Remarks

CAPT James F. Kelly, Commanding Officer, Naval Medical Research and Development Command:

The information needs of the Medical Department Casualty Support Units need to be formally validated. During the period of armed conflict there is a significant number of combatants who are incapacitated by disease; in fact, the

number of such casualties is in excess of those who are injured. Any information system which is developed should take into account the necessity to deal with this non-battle disease category.

In almost all scenarios, there will be a need for inter-operability between the United States and its allies. The development of a Medical Information System should not be done without appropriate interaction with allied forces. During the discussion, it has been evident to me that there has not been a clear distinction made between research and development and operational policy. This needs to be clarified and a logical sequence developed whereby mission statements which reflect operational policy are the basis on which R&D is planned and implemented.

The desirability of a Medical Information System is fully evident, but the cost of such a system needs to be taken into account, in spite of the evident necessity. A careful cost analysis needs to be performed as such a system is being developed in order to assure affordability. The minimum clinical data which is included in such a system should be derived on the basis of validated statements from experienced clinicians. Entry of data into the system should be by a method which is not necessarily dependent on a keyboard. The simplist, most expeditious means of entry should be designed into the system. An Objective Numerical Data Summary such as the Trauma Score should be recognized as being only a guide to patient management. The care of diseased or injured patients includes an application of the art, as well as the science, of medicine and this cannot be lost sight of in an attempt to completely objectify the process. Medical information derived during either exercises or actual battle conditions should be subjected to after-action analysis. It would be desirable to have a methodology available which would provide a matrix for such analyses based on either organ system or discipline. These after-action analyses should serve as the on-going validation of the utility of the Medical Information System. Such feedback is necessary not only for analysis but also to assist clinicians in forward areas to better understand the outcome of their treatment.

The development effort which is being planned during this Conference is predicted on the assumption that there will be a variety of logistical circumstances in which future conflicts are fought. This is undoubtedly true; but

we must not lose sight of the common denominator of therapy--that is, man, and we can assume that the physiology of man will not alter significantly. Our ability to intervene in physiological alterations will be improved, but basic operations will remain the same. Clearly, the output of this effort could effect a fundamental modification in the manner in which we are able to manage casualties in the combat scenario. The capability to accomplish this task rests mainly on the talent of those individuals performing the work at the Naval Health Research Center. I am quite confident that they can, under the direction of Dr. Gunderson, accomplish the stated objectives and that in the future the Navy Medical Department and its sister services, as well as its allied medical services, will be better able to manage the outcome of combat casualties.

Appendices

Appendix A

Fleet Marine Force (FMF) Medical Information System:

Mission Element Need Statement (MENS)

1. Mission Area Identification

a. Mission. The mission of the Navy Medical Department is to support the operating forces in order to maintain or restore the health of the personnel attached thereto. Mission capability RDT&E planning categories are: tactical land warfare (TW), and tactical amphibious warfare (AW). Medical Department personnel in support of TW and AW are stationed in Navy and Marine Corps units afloat and ashore. Advanced base medical facilities also exist in an echeloned evacuation chain leading to fixed definitive care facilities which provide both routine and casualty care. The levels of care and readiness required operational capabilities (ROCs) are defined for the Navy and Marine Corps by OPNAVINST C3501.2E. BUMEDINST 5450.63B tasks the Naval Medical Research and Development Command to conduct biomedical research, including that for health care informational tools, in support of the ROCs.

b. Organizational and Operational Environments. Amphibious Task Forces composed of Navy amphibious ships and Marine landing forces operate in worldwide locations in hostile or friendly environments. In an amphibious operation, the Landing Force medical facilities are established ashore. Casualties are treated by both Landing Force and Amphibious Task Force facilities. In hostile environments, wounded initially are received by both afloat and ashore Medical Treatment Facilities (MTFs) which are part of the evacuation chain. High threat environments increase the possibility of severe trauma, chemical, biological or radiological injury to both the FMF and the supporting Naval Amphibious Force personnel. In addition, many areas of the world pose hazards due to heat and cold. In such settings, casualties may be mainly Disease, Non-Battle Injuries (DNBI) rather than battle casualties.

c. Related Priorities of this Need to Other Mission Needs. Routine and combat casualty care in the FMF generally occur at different times, depending upon the operational situation, and cannot be rank ordered as they are inter-

dependent. However, health care of the FMF is a critical component in measuring readiness and maintaining troop strength.

2. Deficiency

a. Scope

(1) An NMRDC/ONR Technical Working Group of Combat Casualty Care (TWG), conducted in April 1976, and the report of the FMF Medical Information Systems Requirements Definition Workshop, conducted during May 1982, have clearly documented the need for an improved medical information management capability in support of FMF operations. The military operations in Southeast Asia experienced loss of records, incomplete or missing data, and incomplete communication of medical information throughout the medical evacuation chain regarding both the outcomes of treatment and the disposition of casualties. This loss of information resulted in a diminished standard of care compared to that which could have been rendered if the information had been reasonably complete. Moreover, patient records of routine field health care have been too incomplete to support research studies of diseases and nonbattle injuries useful for operations planning.

(2) In order to effectively deal with casualty care in the evacuation chain, all units must possess the capability to deal quickly and accurately with medical information. Compatibility and interoperability between Marine Corps and Navy systems is vital to the management of the echelons of care in amphibious operations. The recording of medical treatment information during the care of casualties in all types of Naval and amphibious operations is manpower intensive and detracts from the ability of Naval medical personnel to provide the best care. However, if this data recording function is neglected in order to deliver vital care, the essential patient care data may be inaccurate, missing, or untimely, thus detracting from the quality of care throughout the system. To solve this problem current technology can be used to provide the needed medical data capture and management capabilities.

b. Jobs to be Accomplished

(1) A field medical system must accommodate all health care functions that require information support in garrison and deployed. The system must maintain a spartan but complete record of the health care delivered to an

individual and must contain the appropriate supporting information. The data capture functions for the system must be designed to reduce, or at least not increase, the present medical information recording burden. The system must provide each echelon of care with an accurate, complete, and timely record of patient care delivered which will result in reducing not only the recovery time of casualties but also the expenditure of staff time and resources used in delivering care. The manual casualty care record must be able to be transferred into a supplementary machine-stored form at the appropriate time to provide timely medical information to each member of the patient care team. Nevertheless, both routine and casualty care must be accommodated in a comprehensive clinical stored patient record which can be used in all FMF operations.

(2) The resulting automated record of routine and casualty care must be transferable to an appropriate machine-readable medium for patient transport in the evacuation chain. This medium must be easily read in the field, resulting in the machine record being recreated at the next echelon medical facility, thus aiding in the continuity of care. The automated record system must expand coded manual entries into plain language for ease of use by care providers, and must extract data for preventive medicine, medical regulation, and logistical purposes, including unit rosters for immunizations, physical and dental examinations, and/or other personnel readiness attributes. New data entries must be able to be freely added at any time.

(3) The availability of accurate medical information in support of routine preventive health care and of effective casualty care in the FMF is essential within the casualty evacuation chain since it enhances patient care and provides basic data for the medical regulatory and medical logistics systems. Several of the Medical Information Management tasks which must be conducted are:

(a) The establishment and maintenance of a patient record file to schedule medical examinations and prophylactic procedures.

(b) The recording of sick call information, encounters, dispositions, and therapy conducted while in garrison and when deployed.

(c) The management and recording of casualty triage, resuscitation, and definitive care information.

(d) The management of the information necessary for conducting diagnostic and therapeutic procedures.

(e) The recording and updating of information related to medications and drug therapy for both routine and casualty care.

(f) The recording and updating of sanitation, environmental, and occupational medicine information for preventive medicine programs.

(g) The recording and updating of information related to accomplishing the functions of a field blood bank.

(h) The accounting for medical equipment and supplies.

(j) The recording and updating of information related to managing and scheduling follow-up treatments.

(4) System development and Initial Operational Capability (IOC) for the full system requirements should be accomplished in two phases. Phase I should include development and IOC for only those data requirements that directly support the treatment of acute care patients in the field, followed by field testing. Phase II should include development and IOC for all other identified data requirements.

3. Existing and Programmed Capabilities

a. Capability To Accomplish the Mission. No projects directed at patient care information support in the field presently exist within the U.S. Army or U.S. Air Force Medical R&D community. However, the U.S. Army Academy of Health Sciences is developing the TAMMIS System which will operate on the TACCS field hardware to conduct Blood Resource Management, Patient Accounting, Medical Logistics, and Medical Regulating functions. The definition of shipboard medical information processing requirements within the Military Sealift Command, directed at both the Sealift and Naval Surface Forces, including the Amphibious Force, is being coordinated with the capabilities being identified for the FMF. Brooke Army Medical Center is automating the in-garrison troop medical clinic functions, but this system will not be field oriented. A nursing information system is being planned by the Naval Medical Command, and its capabilities will be coordinated with the system for the FMF, since its planners have participated in the FMF Requirements Definition. The Naval Military Personnel Command, NMPC-6X, is the executive agent for an automated joint service ID Card (RAPIDS

project) while the Army Military Personnel Center is developing an automated soldier ID Card and dog tag. These projects will supply the common technology for patient identification in the field, and this technology may be used for the FMF system. The proposed FMF Medical Information System Project, which is intended to develop the health care information support capabilities needed by the FMF, will complement and be coordinated with the capabilties being developed within the other joint services as noted above.

b. Impact. The status quo is not an acceptable alternative because the manual information recording system has neither the speed, capacity, or ability to deal with the complexity of the information needed to manage all phases of patient care in high threat environments. The proposed project is a new capability which is critically needed to replace a manual system that neither has the capability nor the flexibility to respond in the time or scale required.

4. Constraints

a. The system must enable the users to collect and maintain the needed data in a reliable field setting without increasing the current burden of recording tasks of health care providers.

b. A prototype system must be developed using RDT&E funding and be ready for Phase I operational testing by the First Quarter FY 1986 with a Phase I initial operational system by First Quarter FY 1988.

5. Coordination and Cost Estimates

a. Because this capability is new to the FMF, the total cost for a single operational system can only be estimated after the evaluation of prototypes, since costs for the technology are changing rapidly at this time. The total estimated cost for developing a single prototype will be approximately $150,000 and will be borne from Navy RDT&E funds. The first prototype system will contain all of the basic functional modules for support of acute care patients at Echelon III MTFs. It is expected that continuing software maintenance, hardware acquisition, and hardware maintenance costs for operational systems will come from the Naval Medical Command for accepted functions while the cost of implementing new functions will continue to come from RDT&E funds.

b. It is estimated that $60,000 and nine man months will be required to conduct the concept definition phase. Research and technical development will

take place at the Naval Health Research Center, Naval Ocean Systems Center, San Diego, California and the Naval Submarine Medical Research Laboratory, Groton, Connecticut, with advice and approval from the Naval Medical Data Services Center.

c. This MENS is submitted by the Naval Medical R&D Command to the Naval Medical Command in response to operational requirements stated by the CMC for approval to conduct, through research sponsored by the Naval Medical Research and Development Command, investigation into the technical capabilities required to provide the FMF with an initial operating capability. This research and detailed requirements definition will be conducted under the guidelines of SECNAVINST 5231.1A so that documentation produced will enable Navy Department wide applicability of the results and of any ADP solutions that are recommended to the CMC and NAVMEDCOM.

d. Approval of this request will initiate a project at the Naval Medical Research and Development Command with the issuance of initial work units based on FY85 funds. Formal submission will be made to include this project in the POM for FY86. The project will produce System Decision Papers and initial demonstration prototypes which will be used for decisions by the CMC on their operational suitability. The system documentation and these prototypes will be submitted to the CMC (Code MED), BUMED, and NAVMASSO for review and approval before the advanced development of operational systems is begun.

Appendix B

Combat Scenarios

Part 1

The Navy-Marine Corps team, in order to provide effective in-theater medical support during a contingency, must establish a continuum of care from the forward edge of the combat zone to the continental United States, essentially establishing a medical organization where none may have existed previously. The concepts for providing support may be best understood by reviewing the sequence of events that must take place.

The highly mobile company corpsmen and battalion aid stations go ashore on landing day with the assault force and provide very limited first-aid and resuscitative care to casualties. Once the assault force is established ashore, about landing day plus five, the more capable Marine Corps medical companies and hospital companies are phased ashore. In the interim, casualties can also be sent to casualty receiving and treatment ships offshore.

The five medical companies with two operating rooms and 60 beds, which are organic to a Marine Amphibious Force, represent the next echelon of care for patients coming from forward battalion aid stations. Medical capability is limited to life-saving surgery and resuscitative care. Available holding capacity permits only very brief holding of patients prior to evacuation rearward.

The hospital company with its six operating rooms and 200 beds also begins landing about day five and provides additional medical capability to accommodate combat "surges" which may exceed medical company capabilities. Patients from the hospital company flow to casualty receiving and treatment ships and to hospital ships and fleet hospitals.

The amphibious task force ships provide emergency resuscitative, stabilization, and surgical care that is beyond the physical capacity of Marine Corps units. (VADM J. W. Cox, MC, USN, Surgeon General, Statement to House Armed Services Subcommittee, 24 March 1982.)

Part II

Let us assume that we are required to commit a one division, one aircraft wing Marine Amphibious Force (42,000) to a mid-intensity amphibious assault on the southern flank of NATO. We shall assume that the amphibious assault phase will require two days, and that the amphibious task force will remain in direct support of the MAF for a total of five days. During the initial two days, we would anticipate approximately 325 casualties, after which time our rate would stabilize at approximately 90 casualties per day. With the amphibious task force in direct support, we shall assume that the first five days of casualties, approximately 596 patients, will be treated aboard ship.

While these combat operations are ongoing, we would be unloading our five medical companies of the force service support group in order to provide medical support ashore. Each medical company carries with it, organically, a 60-man hospital capability, so that at the end of five days, we would have established a 300-bed total capability ashore. In addition to the medical companies, we also have one hospital company, with a 200-bed capability, in the force service support group. This organization is designated to arrive with the assault follow-on echelon of amphibious shipping and should arrive in the objective area by D+5 and be established ashore by D+10, giving us a total capacity of 500 beds. Here I must remind you that when I say "beds," I mean cots in a tent which, from an environmental or climatic point of view for the treatment of trauma patients, is no improvement over the medical facilities used in the Civil War.

During this time, combat operations are continuing with air support being provided from airfields outside of the amphibious objective area and from the carrier task forces at sea. If all goes well, we shall be able to capture and rebuild an enemy airfield or establish an expeditionary airfield ashore by D+15.

While all of this has been going on, we have been sustaining our daily casualty rate of approximately 90 men per day. This means, in simple terms, that by the time we are able to commence medical evacuations from the battle area, we already have 400 patients more than we can support. If we apply the Department of Defense planning guidance of a 60-day evacuation policy, we shall have somwhere in the neighborhood of 1,500 casualties lying around waiting for

treatment. From a statistical point of view, this level of medical support is totally unacceptable. (Lieutenant General L. F. Snowden, USMC, Medical Support for Marine Corps Operations, Proceedings, Technical Workshop on Combat Casualty Care, 1976, p. 41.)

Let me list some of the reasonable assumptions on which plans might be based.

1. The most certain assumption is that the medical aspects of the next war will not be like the last, in Vietnam. That probably was the last of our leisurely wars. The plan we now devise, and the equipment for combat casualty care on hand at the beginning of the next war, will probably be that which will be operative during the entire conflict. It is unlikely that we shall, again, have the luxurious months and years to change plans, equipment in mid-war, or to have untouched, unbombed civilian economy at our beck and call. It is also unlikely that medical affairs will be given the high priority afforded during the Vietnam War.

2. We shall not enjoy unlimited air power. Helicopters, the essential feature of primary casualty evacuation in the 1960's, cannot be relied upon. Extraction from the hot-zone of wounding to a point of initial surgical care will almost certainly have to be by wheeled and, perhaps, armored vehicles, or even by hand litter.

3. As a result, the majority of casualties (or so we had better plan) will not be given initial definitive surgical care within 1-3 days. Many will die forward of surgical care. Many who reach the surgeon will have infected, not merely contaminated, wounds.

4. Forward hospitals will probably be under rocket, missile, or artillery fire.

5. There will be competition for medical personnel, supplies, and equipment for civilian casualty care.

6. Radiation or burn casualties from tactical nuclear weapons is almost a certainty.

7. Neither troop nor medical facility concentration, be it on land or afloat, will be immune from missile attack. Concentration of forces, a fundamental Napoleonic military tenet of efficiency and effectiveness, will probably have to be sacrificed as providing too tempting a guided missile target. Dispersion, both afloat and ashore, however inefficient, is an unwanted, but inexorable, dictum when offensive weapons dominate.

8. The nation, even in wartime, will insist that medical methods be cost-effective. Both civilian and military health care, whether we like it or not, now is considered merely another public utility. Neither emotion nor bygone historical prestige can be relied upon to carry much future clout.

9. The mechanics of war in this technologic age change rapidly, and with each change subsequent combat casualty care is altered. Professional isolationism between combat technologists and medical department is a luxury we cannot afford. Neither we nor our line counterparts can make future plans apart from each other.

Such assumptions provide the medical planner with an awesome challenge. One that can be met intelligently only by medical officers well versed in both medicine and the advanced art and science of modern warfare. (RADM B. Eiseman, MC, USNR, Planning for Combat Casualty Care, Proceedings, Technical Workshop on Combat Casualty Care, 1976, p. 51-52.)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 84-15	2. GOVT ACCESSION NO.: AD-A150133
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): PROCEEDINGS OF THE CONFERENCE ON FLEET MARINE FORCE COMBAT CASUALTY INFORMATION SYSTEM	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): E. K. Eric Gunderson and Diane M. Ramsey-Klee M. W. Congleton	8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Health Research Center P. O. Box 85122 San Diego, CA 92138	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: M0095-PN.001-1047
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Medical Research and Development Command Naval Medical Command, National Capital Region Bethesda, MD 20814	12. REPORT DATE: October 1984 13. NUMBER OF PAGES: 140
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Commander, Naval Medical Command Department of the Navy Washington, DC 20372	15. SECURITY CLASS (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for public release; distribution unlimited.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Combat casualty care
Fleet Marine Force
Trauma care
Medical Information Systems

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Conference on the Fleet Marine Force (FMF) Combat Casualty Information System consisted of technical presentations, hardware and software demonstrations, and workgroup discussions. The purpose of the Conference was to bring together experts in Navy medicine, trauma care, FMF operations, computer systems, and software design in order to evaluate progress to date and to provide feedback and guidance to system designers. Approximately 75 participants from the Navy, Marine Corps, Army, Air Force, and computer technology

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

private sector attended the three-day Conference. The results of the Conference will be used to define a combat casualty medical record, develop software tailored for each echelon of casualty care, and identify appropriate hardware based on the most advanced technology and capable of withstanding the severe environmental conditions that may be encountered in a combat setting.